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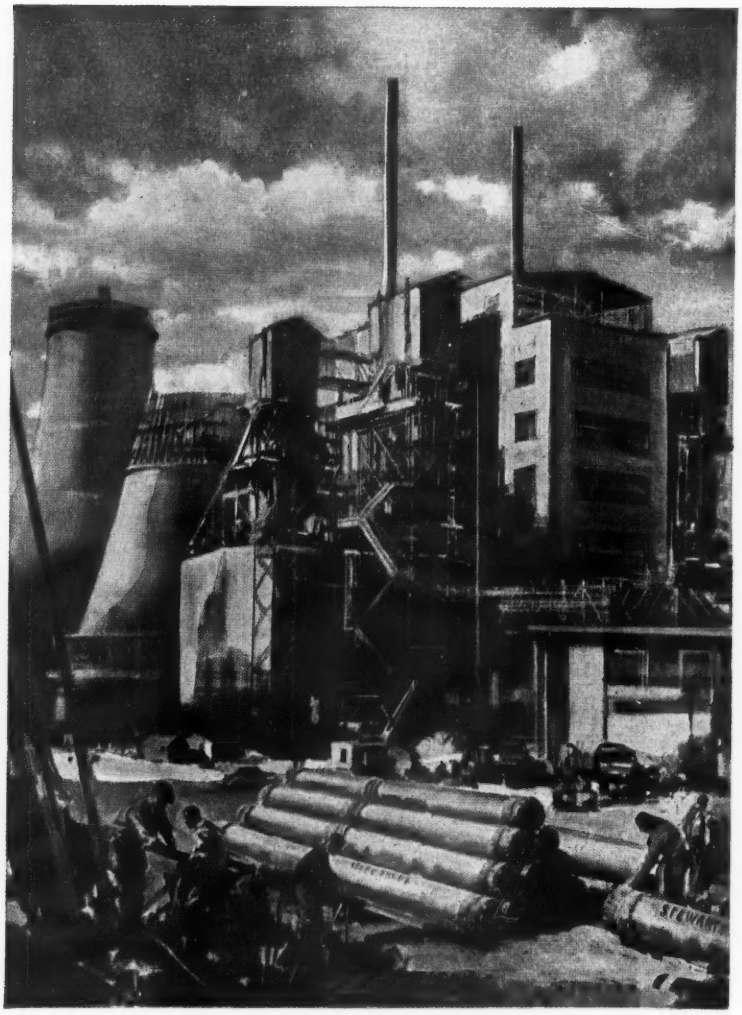

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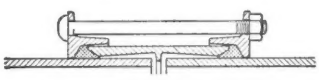

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19 OCTOBER 1956

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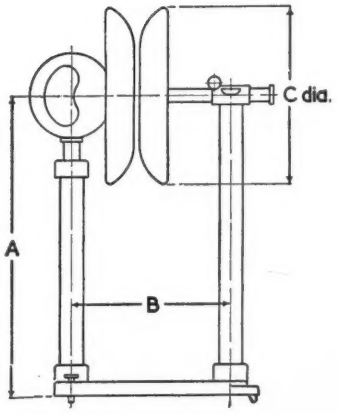

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ELECTRICAL REVIEW

19 October 1956 Vol. 159 No. 16 Established 1872

Outstanding Achievement

HISTORY was made on Wednesday last, 17th October, when H.M. the Queen officially opened the 92 MW Calder Hall " A " nuclear generating station in Cumberland, because for the first time anywhere in the world a full-scale power station employing nuclear reactors as the means of generating heat was put into commercial operation, feeding electrical power into the national supply network. The successful design, construction and operation of this plant represents a most outstanding achievement which has demonstrated British skill and ingenuity to the world, and all those engineers and scientists who have been concerned with the project are to be heartily congratulated on what they have done.

We have visited the Calder Hall site on a number of occasions throughout the constructional period and we have been most impressed by the enthusiasm with which everyone engaged on the project, both engineers and workmen alike, have been applying themselves to their tasks. Every man on the job appeared to have a personal interest not only in what he himself was doing but also in the project as a whole and it has been obvious that all concerned were fully aware of the vital national importance of the work.

This has no doubt accounted for the repeated advancement of " target " dates despite the fact that the work involved has been of a pioneering nature entailing the development of numerous new techniques, often under field conditions. Furthermore, the limits of accuracy and almost clinical cleanliness demanded in some sections of the plant have hitherto never been encountered in normal power station practice. Calder Hall has been constructed in record time for a power station, irrespective of the fact that it is a nuclear plant departing fundamentally from established practice. It is remarkable that the plant is working to-day because little more than ten years ago this country had no organisation for studying or exploiting nuclear power in any form.

In 1945, it was announced that the first British Atomic Energy Centre was to be established at Harwell and subsequently the Ministry of Works co-operated with the Ministry of Supply Atomic Energy Division in the construction of Harwell, Aldermaston and the atomic energy factories under the headquarters office at Risley. In 1946, the Ministry of Supply establishment responsible for the construction of the atomic energy factories was set up at Risley under the direction of Sir Christopher Hinton. A strong M.O.W. section was seconded to work with the M.O.S. design staff on the various projects, including the Springfields factory, Windscale piles and chemical separation plant, Capenhurst diffusion plant and Calder Hall power station. This

arrangement continued until August, 1954, when the United Kingdom Atomic Energy Authority was formed; the M.O.S. and M.O.W. staff who wished to stay with them were then absorbed.

By the spring of 1952 the 1951-52 design study for a gas-cooled, natural uranium power reactor had been developed to the stage when Harwell could seek advice from the British Electricity Authority (now C.E.A.), the M.O.W. and a number of specialist firms. These organisations were brought into the project and their work was co-ordinated by Harwell through the Plant Co-ordinating Committee set up in April, 1952. Thus a preliminary construction programme was prepared. The designs were largely completed by April, 1953, when the Thermal Reactor Design Office was opened at Risley and the Minister of Supply announced that an experimental nuclear power station was to be built at Windscale. Work started immediately and to-day the plant is operating successfully.

British engineers have shown the world what they can do and their work provides very firm foundations for the programme of nuclear power station construction which the Central Electricity Authority has embarked upon. Calder Hall is only the beginning. Already the designs for later stations represent a substantial advance on the extraction of useful heat and new ideas and methods will constantly (and rapidly) be introduced. It is evident that the original estimate of 1,500 to 2,000 MW of nuclear power plant by 1965 given in the White Paper of February, 1955, will prove to have been extremely cautious.

DIRECT ATOMIC ELECTRICITY

Dealing with the measurement of atomic energy in his inaugural address to the Radio and Telecommunications Section of the Institution of Electrical Engineers, reported on page 721 of this issue, Dr. Robert C. G. Williams referred to "the attractive possibilities of deriving electrical energy direct from atomic fission and fusion effects without the intervention of the heat engine."

This is rather the sort of thing we had in mind in the earlier days of electrical energy generation from atomic power when we said that it was curious that electrical energy in the fission material would first have to be converted to heat and then back to electrical energy again before it could be applied to the use of man.

As Sir Christopher Hinton said at the inaugural meeting of the British Nuclear Energy Conference, "No one knows quite what is round the corner." Whatever happens the electrical industry and its personnel must have the courage to face up to these attractive possibilities. Their development would still remain in the hands of the electrical industry if the industry were not so foolish as to shut its eyes to the march of events.

DOMESTIC APPLIANCE SALES

Although the gas industry earned a small surplus in 1955-56, the Gas Council's report for the year is not an encouraging one. Sales of gas to industry increased by 4 per cent but on the domestic side there was a decline of 2 per cent. In the same year the industrial consumption of electricity was 8·8 per cent higher than in 1954-55 while domestic consumption went up by 11 per cent—apart from a rise of 11·7 per cent in farm supplies. It seems as though the gas industry has been hit rather more than electricity supply by the hire-purchase restrictions and increase in purchase tax. With the sole exception of refrigerators, for which a small increase was recorded, the sales of all gas domestic appliances showed a falling-off. In the case of cookers this was very serious, amounting to 28·5 per cent.

Although the situation was bad enough for the electricity supply industry, it did not suffer so severely as gas. Earlier in the year the Central Electricity Authority published figures of appliance sales in 1955-56 showing that cooker sales had fallen by 18·5 per cent, as compared with the preceding year's figures, and washing machines by as much as 23·3 per cent. Conversely, there was a rise of 28·5 per cent in refrigerator sales and one of 5·9 per cent in those of water heaters.

It has to be remembered in making these comparisons that in the electrical industry quite a substantial proportion of the appliance trade is done by retailers—much more so than in the gas industry—although it is probable that the effects on private trade have been about the same.

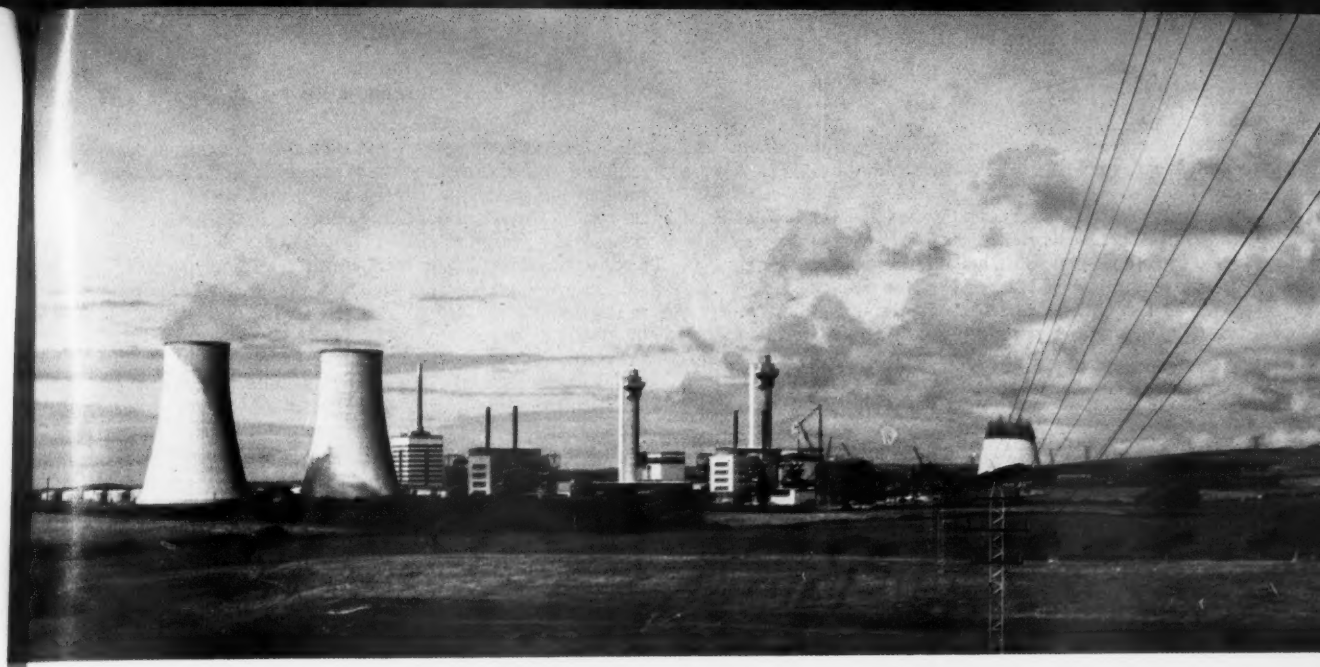
TELECOMMUNICATIONS DEVELOPMENT

At the jubilee meeting of the Institution of Post Office Electrical Engineers last week, reported on page 719 of this issue, Brigadier L. H. Harris made a most informative review of the advance of telecommunications during the last fifty years. One of the things which he stressed was that conversion to automatic exchanges started as early as 1912 and the first full-scale automatic exchange was established at Holborn in 1927 when there were about a million subscribers. We realise that a world war with its long period of non-production has occurred since that time, but it seems a little surprising that to-day, thirty years later, there are still so many manually operated exchanges throughout the country although we doubt whether it will ever be possible to reach the stage of 100 per cent automatic operation because of the inevitable isolation of many exchanges.

Brigadier Harris also drew attention to the great development of telephone underground cables which has been achieved in recent years and here again we feel surprised that so great a number of overhead lines are still to be seen in many urban districts throughout the country.

ANNUAL DOMESTIC ISSUE

Next week's *Electrical Review* will present our annual survey of domestic electrical equipment showing what is available and illustrating trends. The contents will include a number of articles dealing with practice in Continental homes



Electrical Review 19 *October* 1956

Calder Hall seen from the east with the two Windscale reactor towers and irradiated fuel processing plant in the background. To the left are the two "A" station cooling towers and in the centre are Nos. 1 and 2 reactors each with a pair of stacks. One of the "B" station reactors and a cooling tower can be seen in course of construction

Calder Hall Generating Station

WORLD'S FIRST LARGE-SCALE NUCLEAR POWER PLANT

WHEN the 92 MW Calder Hall " A " generating station in Cumberland was officially opened by H.M. the Queen on Wednesday last, 17th October, in effect the age of nuclear power was inaugurated since, for the first time anywhere in the world, a large-scale nuclear power station was put into full commercial operation to feed electrical energy into a national supply network. Electricity was generated at Calder Hall for the first time late in the evening of 27th August, which is a remarkable achievement since the work began only just over three years ago. All the engineers concerned with this project are to be congratulated on what they have done to put Great Britain in the forefront in the generation of electricity from nuclear energy. The work involved has been of a pioneering nature entailing the development of numerous new techniques, often under field conditions, and the limits of accuracy and almost clinical cleanliness demanded in some sections of the plant have hitherto never been encountered in power station practice.

As most of our readers will probably remember from previous articles which we have published in connection with this plant, which has been designed and is being constructed by the United Kingdom Atomic Energy Authority, there are two graphite-moderated gas-cooled nuclear reactors in Calder Hall " A " generating station and each of these is associated with four heat exchangers which generate steam at 200 lb/sq in and 590 deg F, and 53 lb/sq in and 340 deg F for the four 23 MW turbo-alternators in the main station building. At present, two of the turbo-alternators and one of the reactors with its associated heat exchangers are in commission and it is anticipated that by the end of this year the remainder of the plant will be completed and in service. Work is now well advanced on Calder Hall " B," a station of identical design and capacity on the same site, which is planned for completion towards the end of 1958.

The station is situated on the eastern bank of the River Calder roughly half-way between the villages of Seascale on the west coast of Cumberland and Calder Bridge about three miles inland. A few hundred yards away is the well-known Windscale factory of the U.K.A.E.A. where plutonium is produced. The site is remote and unusually inaccessible for a power station. There are no railway facilities at all, the only means of access being one narrow, winding road. This is of little account, however, since the problems of fuel transportation associated with conventional thermal power stations do not exist in this case. At Calder Hall a few lorry loads of uranium fuel elements from the Springfield factory where they are made, some 90 miles away, will do the work of thousands of railway wagons of coal. Cooling water for the condensing plant is of course required and supplies for make-up purposes are normally obtained through a pipeline from Wast Water about eight miles away on the edge of the Lake District, but provision is also made to use water from the River Calder on one side of the site and the River Ehen about a mile away towards the coast.

The main station building, which accommodates the four turbo-alternators, condensing and feed cooling equip-

ment (there is no feed heating train), transformers and switchgear, runs roughly north to south and is 242ft long by 137ft wide by 58ft high overall. It is a steel-framed structure with a steel decking flat roof and corrugated asbestos sheet walls which, with large expanses of glass, give the whole a pleasing appearance despite its utilitarian construction. Parallel to the turbine house and connected to it by a corridor is the administration building which is 242ft long by 60ft wide by 20ft high overall. This accommodates the offices, chemical and physical laboratories, workshops, stores and canteen. The turbine room and administration building are also joined by the control room block which houses earthing rooms, battery rooms, switch rooms, metering room and the main electrical control room itself.

In alignment with and adjacent to either end of the turbine house is a reactor building of similar design and construction 150ft long by 290ft wide including the reactor coolant blower houses. The main reactor buildings are 122ft high with two ventilating stacks reaching up to 200ft. With the blower houses each reactor building is in the shape of a cross with the four heat exchangers disposed in the four corner spaces. To the south of and in line with the two reactor buildings and turbine room are two 290ft high 3,000,000 gal/hr reinforced concrete cooling towers. Each tower diameter at the ring beam is 200ft and the throat diameter 104ft, the pond being octagonal in shape 230ft between flats and about 9ft deep. The reactor buildings and turbine room of Calder Hall " B " are aligned with the " A " station, the two associated cooling towers being placed on either side of the centre line through the whole plant at the north end of the site.

Construction of Buildings

The building and civil engineering contract was placed in July, 1953, and now all work is complete with the exception of certain painting on the second reactor. In addition, the building and civil engineering work on the second power station, Calder Hall " B," is about 75 per cent complete.

A particularly important part of the building work has been the construction of the concrete rafts on which each reactor building is founded and of the octagonal "biological shields " for the reactor pressure vessels which fulfil the dual purpose of structural support and shielding of the operators against nuclear radiation. Each of the 130ft long by 11ft deep rafts contains about 5,600 cu yd of concrete and 270 tons of reinforcing steel. Exceedingly close tolerances on both vertical and plan true dimensions were required in the erection of the 7ft thick reinforced concrete walls of the shields, which rise to a height of 90ft. Great care had to be taken in placing concrete in confined spaces around the large number of charging and other tubes passing through the shields. Further reinforced concrete shielding, in the form of envelope walls around the faces, is incorporated in the design and each shield is covered by an 8ft thick reinforced concrete roof slab which forms the reactor charging floor.

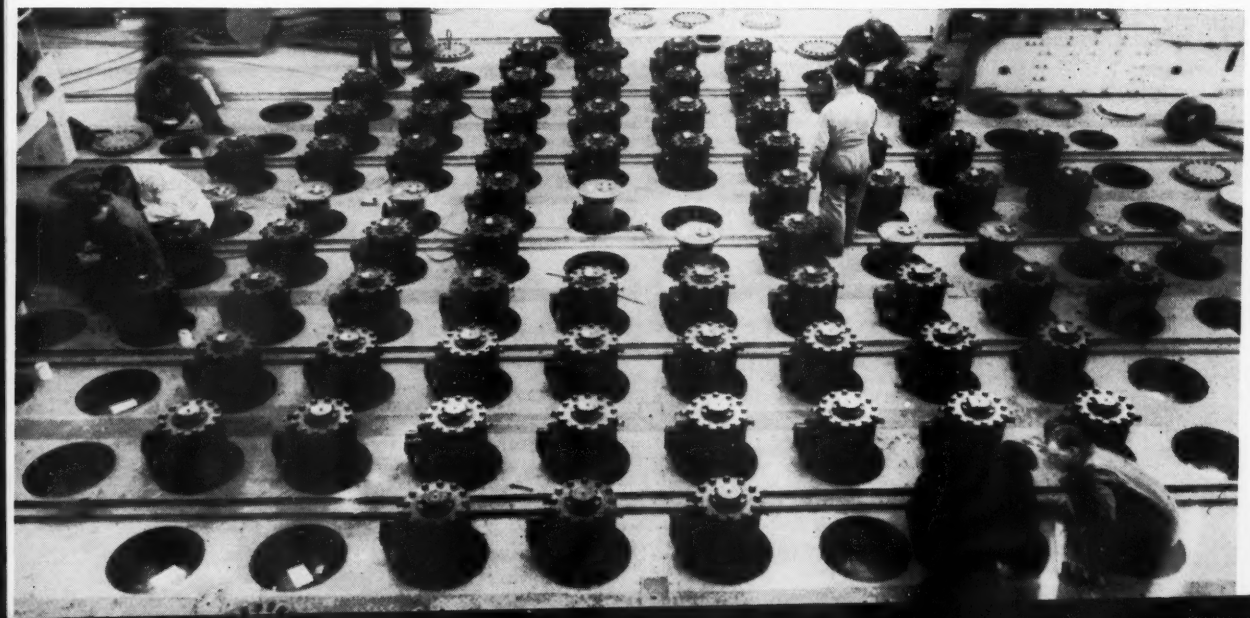
To ensure the efficiency of the biological shield it was essential that the concrete should be of a high and uniform density of 150 lb/cu ft, as compared with the normal requirement of 145 lb/cu ft. This was done by strictly controlling the weighing of all aggregate, sand, cement and water. A wetting agent was used to increase workability with a lower water/cement ratio and in placing the concrete it was vibrated by internal vibrators. Tests have shown that the average wet density achieved was about 158 lb/cu ft. In the dried-out state under operational conditions the density is somewhat lower than this but still provides a margin above the specified figure.

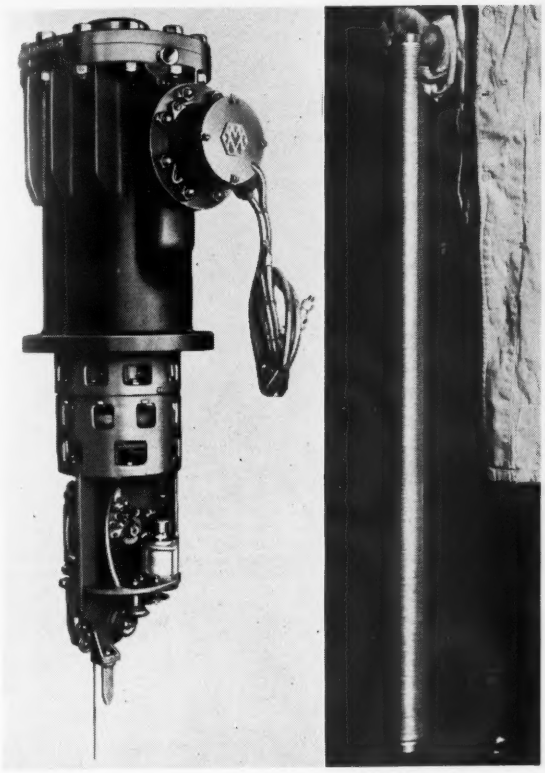
At the cooling towers, which were completed ahead of schedule, work was carried out from an internal scaffold of prefabricated steel, so that as progress was made on the first tower, part of the scaffold was suspended from the shell and a start was made on the second tower with the aid of the released lower portion of the scaffold. In this way a rate of one 3ft lift a day was reached and maintained.

The turbine hall group including the control block, administration buildings and workshops, was constructed on traditional lines with one important exception. Each of the four identical turbine blocks was concreted in one lift. The design and manufacture of shutters of the necessary accuracy and close liaison by telephone between the various working levels within the shutters and the central control of the whole operation were features of this achievement.

The heart of a nuclear generating station is the reactor and this together with the associated pressure vessel and heat exchangers is the most interesting part of Calder Hall, since the rest of the plant comprising the turbo-alternators and their auxiliaries are of more or less conventional design, although there are some unusual features because of the steam conditions employed. For instance, the customary feed heating system employing bled steam from the turbines is not present and in its place there are arrangements for cooling the condensate before it is pumped back

On the charge floor there is a pattern of 112 charge tube holes each of which serves 16 fuel element channels in the moderator block



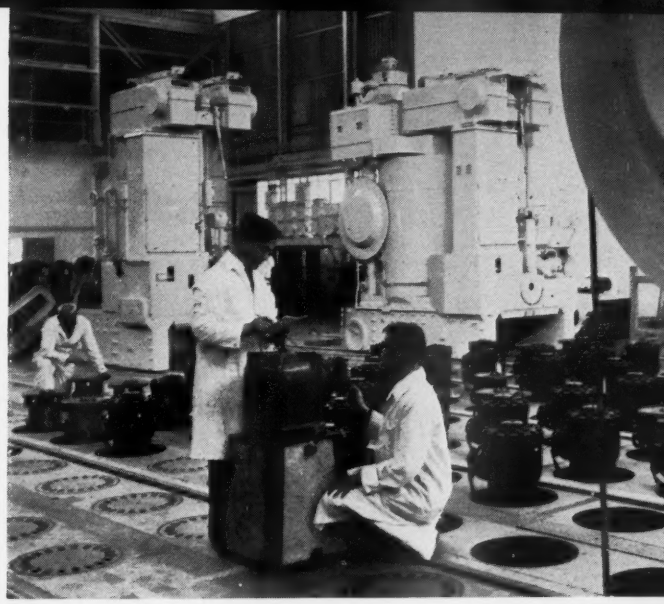


Left: Boron-steel control rod operating mechanism and (right) natural uranium fuel element in its heavily finned magnesium alloy can

into the boiler. The main reason for adopting this technique is to ensure that the maximum amount of heat is extracted from the nuclear reactor.

Essentially, the reactor is a cylindrical mass of graphite incorporating vertical channels in which uranium fuel is placed. This is housed in a cylindrical pressure vessel with four inlets and outlets connecting to the heat exchangers generating steam for the turbines, CO_2 gas being circulated through the system by means of four large centrifugal blowers to transfer heat from the reactor to the water in the heat exchanger tube banks. The operation of the complete plant can best be understood by reference to our inset illustration, which indicates the movement of uranium fuel, and flow of CO_2 heat transfer medium, steam and condensate, as well as the detailed constructional arrangement of the whole plant.

The main pressure vessel, which houses the reactor core and operates at a gas pressure of 100 lb/sq in, is fabricated from aluminium killed high manganese mild steel 2in thick. It is cylindrical in shape, set with its axis vertical, with domed ends, having an inside diameter of 37ft, a height of 71ft 6in and a total internal volume of 57,500 cu ft. Four 54in diameter outlet ducts for the CO_2 coolant leave the top sides of the vessel. The bottom of the pressure vessel is of reduced diameter and it is to this section that the four inlet ducts are attached. The whole of the pressure vessel is covered with 7in of high-temperature lagging on top of which is 2in of magnesia compound, this finally being covered with aluminium cleading. The pressure vessel was fabricated and stress-relieved using electric heating elements on site, after which the whole interior was wire brushed until it was scrupulously clean. All those who subsequently had to enter the vessel wore special



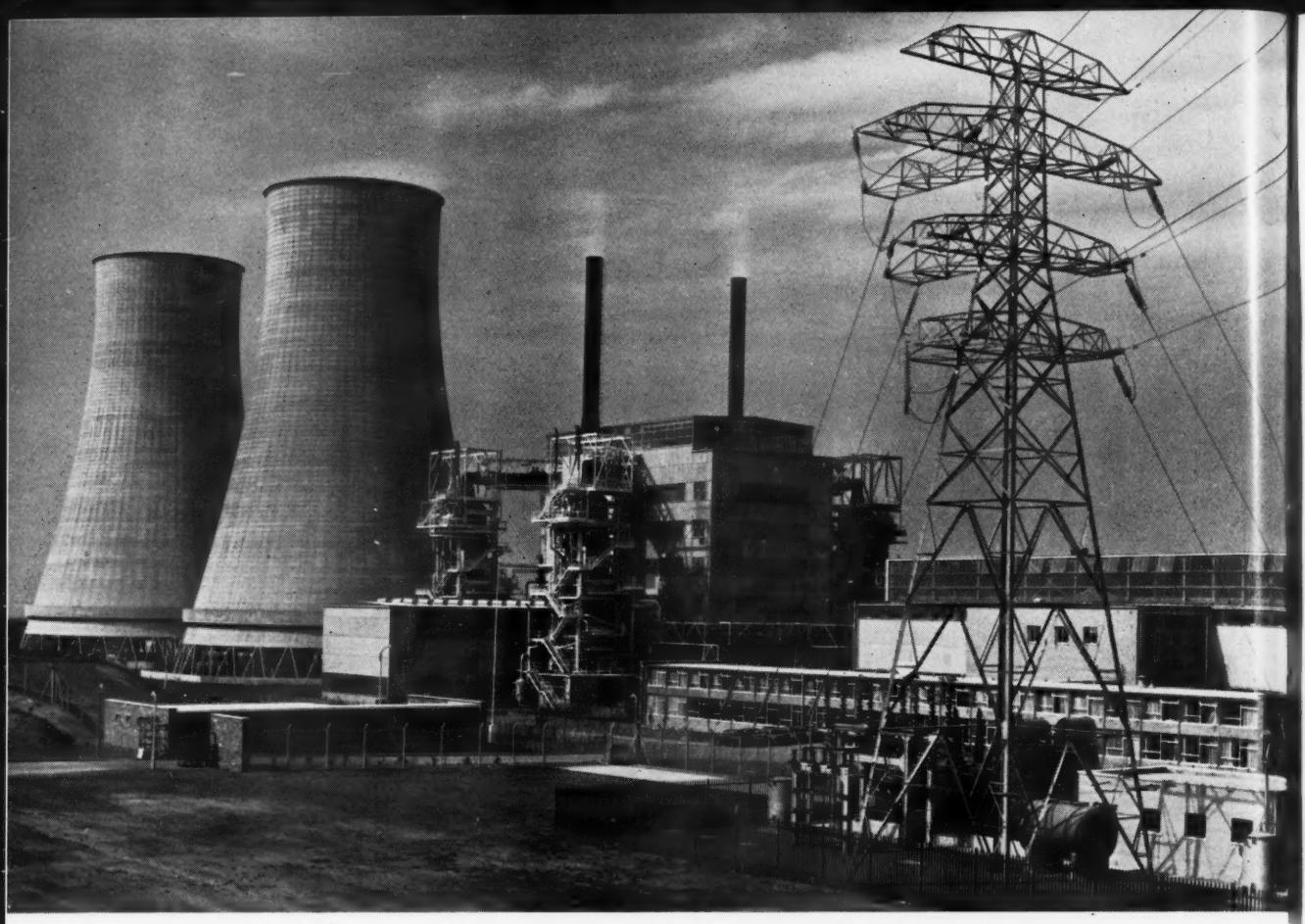
Fuel elements are inserted into the reactor core by lightly shielded charge machines (rear-left) and when irradiated they are removed by heavily shielded discharge machines (rear-centre)

clothing to ensure complete cleanliness of the reactor core.

As stated, the pressure vessel is inside an octagonal biological shield of reinforced concrete 7ft thick and with an 8ft thick reinforced concrete roof which forms the charging floor of the reactor. It is through this floor that steel tubes pass down into the pressure vessel and through which control rods and fuel elements are passed. The whole of the inside surface of the biological shield is protected from thermal and radiation effects by means of a thermal shield made up from 6in thick mild steel plates. It is set away from the wall by about 6in and induced draught air cooling is provided for the space between the thermal and biological shields, the outlet air being exhausted 200ft above ground level from the two stacks on the reactor building. The charging tubes are air cooled in a similar fashion. Each stack accommodates two fans each of which delivers air at the rate of 64,000 cu ft/min and is driven through V belts by a 120 h.p. 1,470 r.p.m. squirrel cage motor arranged for direct-on-line starting.

Details of Reactor

The graphite core of the reactor, which has a consistency roughly approximating to that of an H pencil lead, is cylindrical in shape and has a nominal diameter of 31ft and a height of 27ft. It weighs 1,200 tons and is made up of blocks about 8in square by 2ft high with a vertical hole of 4in diameter running down the centre. These blocks are extrusions which are subsequently machined to within $\pm 0{\cdot}002$in. They are placed in position with extreme accuracy so that the vertical holes (for the uranium fuel and boron control rods) match up exactly from the top to the bottom of the reactor core and so that the coolant gas which passes vertically up through the moderator goes only through the 4in channels and not through the interstices between the graphite blocks. The blocks towards the centre of the reactor have a very low neutron absorption cross section, whereas those around the periphery which reflect neutrons back towards the centre of the graphite moderator are of a lower grade. Altogether there are 1,696 fuel element channels in the moderator block and in the fully charged state these will hold roughly 130 tons of natural uranium, there being six uranium cartridges one on top of the other in each channel. In the centre of each group of sixteen fuel element channels is a further vertical channel for a boron steel control rod. The design of the reactor is such that it will reach the critical state



Calder Hall "A" showing the grid substation, part of the turbine building, No. 1 reactor, and the two cooling towers

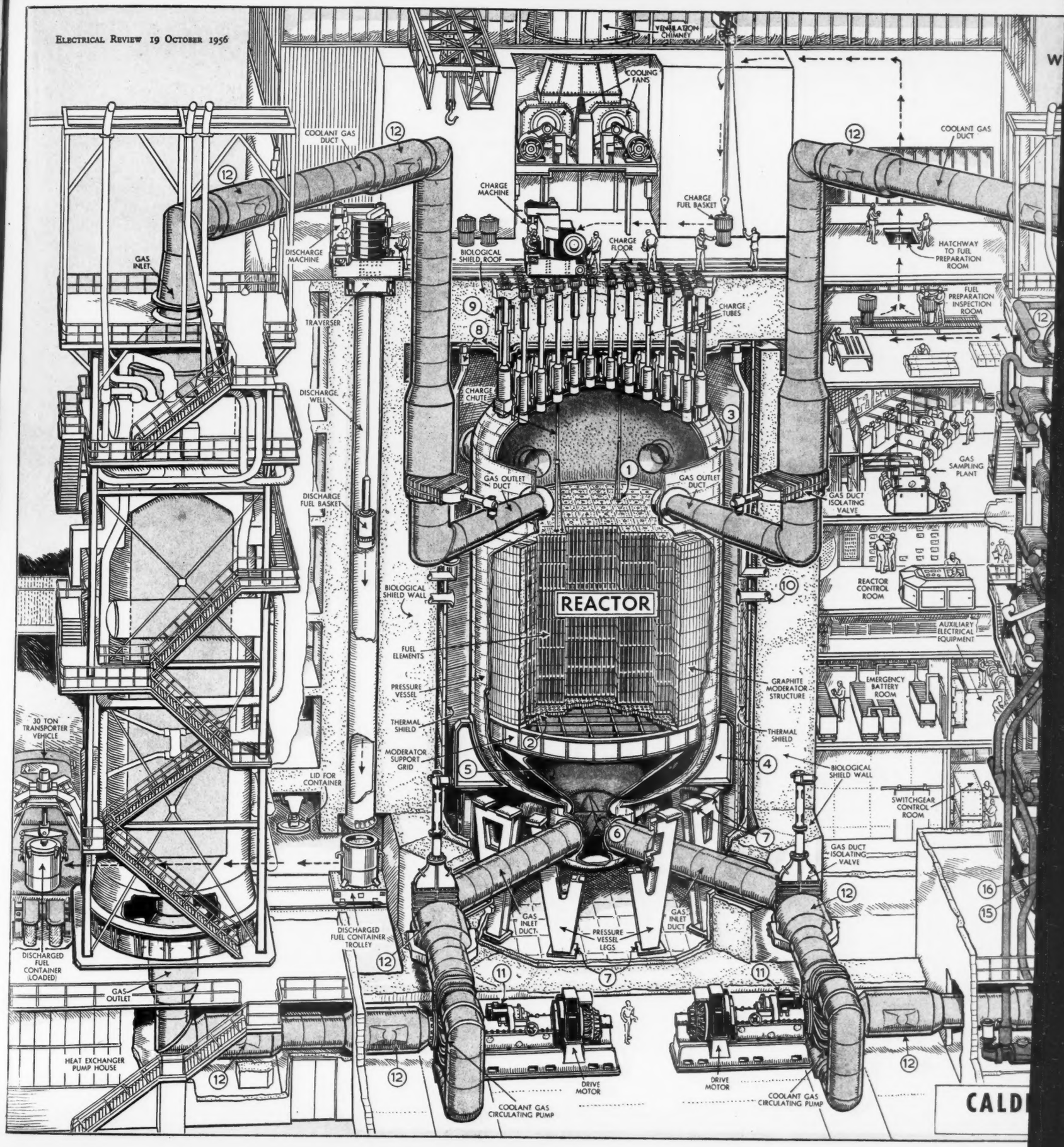
(i.e. the chain reaction begins) when about 40 tons of uranium have been inserted into the graphite core.

The mass of graphite moderator sits on 4in flat steel plates in such a way as to permit expansion and these plates are set on a 63 ton diagrid structure which consists of an I-section ring girder spanned by further steel girders forming a rectangular lattice. The 4in base plates bolted to the diagrid have holes drilled in them to coincide with the channels in the graphite. The graphite does not sit directly on the steel plate but is supported upon a number of ball races to allow for the differential thermal expansion of the graphite and the diagrid. The weight of the graphite and diagrid is taken by brackets directly through the walls of the pressure vessel on to ten inverted A frames which rest on bases supported from below the thermal shield floor. These frames are loosely bolted to the brackets on the pressure vessel and on to the thermal shield, the three contact surfaces of each frame being radiused. In this way, allowance is made for radial thermal expansion of the pressure vessel and diagrid when the A frames roll slightly out of the vertical position, and the bolts ensure that the rolling surfaces do not slip.

For fuel the reactor uses natural uranium in the form of 1·15in diameter rods 40in long contained in machined magnesium alloy cans. Each can has single start helical fins on a cylindrical barrel sealed at one end by a plug and end cap and at the other end by a spacer and end cap; the inside diameter is 1·165in, the outside diameter 1·30in and the diameter over fin tips is 2·125in. The design of the Calder Hall reactors is such that the heat energy released from the uranium fuel is about 3,000 MW days per metric ton. In the initial stations to be built by the Central Electricity Authority, which will be of basically similar design, electricity will be generated at a cost of approximately 0·5 to 0·6d/kWh; a more accurate estimate of costs, relating to Calder Hall, will be available when the results are published of a study which is at present being made of the overall economics of nuclear generation taking into account the sale of the plutonium.

Fuel is delivered to the station from Springfield in batches of three elements in steel cases, each element being inside a protective cardboard tube. The fuel elements are first taken into what is known as the control side of the reactor building where they are transported by lift up to the fuel preparation room on the fourth floor which is immediately below the charge floor. Here they are unpacked and visually inspected for faults, assembled ready for use, and packed into magazine type charge baskets which hold 24 fuel elements each and are on a roller conveyor for ease of movement. Next, the baskets are hoisted up to the charge floor through a steel trapdoor and are immediately placed in a charging machine.

On the charge floor there is a pattern of 112 charge tube holes straddled by six sets of rails on which the charging and discharging machines run; each charge tube serves 16 channels in the moderator block. Essentially, the charging machines are electrically driven mobile winch operating units which lower the fuel elements down into the moderator block. The winch is driven by a reversing motor having a widely variable speed range which allows an operating speed of 175 ft/min together with creep speeds at the extremities of the motion. At the end of the hoist cable is an electrically operated grab which includes the necessary electromagnetic devices for remote control and indication. The grab itself operates automatically and on the machine there is an accurate indicator which tells the


VENTILATION CHIMNEY
COOLING FANS
COOLANT GAS DUCT
CHARGE MACHINE
CHARGE FUEL BASKET
CHARGE FLOOR
HATCHWAY TO FUEL PREPARATION ROOM
FUEL PREPARATION INSPECTION ROOM
GAS INLET
DISCHARGE MACHINE
BIOLOGICAL SHIELD ROOF
TRAVERSER
CHARGE TUBES
DISCHARGE WELL
CHARGE CHUTE
GAS SAMPLING PLANT
GAS OUTLET DUCT
GAS DUCT ISOLATING VALVE
DISCHARGE FUEL BASKET
REACTOR
BIOLOGICAL SHIELD WALL
REACTOR CONTROL ROOM
AUXILIARY ELECTRICAL EQUIPMENT
FUEL ELEMENTS
PRESSURE VESSEL
GRAPHITE MODERATOR STRUCTURE
EMERGENCY BATTERY ROOM
THERMAL SHIELD
30 TON TRANSPORTER VEHICLE
MODERATOR SUPPORT GRID
LID FOR CONTAINER
SWITCHGEAR CONTROL ROOM
GAS INLET DUCT
PRESSURE VESSEL LEGS
DISCHARGED FUEL CONTAINER TROLLEY
DISCHARGED FUEL CONTAINER (LOADED)
GAS OUTLET
HEAT EXCHANGER PUMP HOUSE
DRIVE MOTOR
COOLANT GAS CIRCULATING PUMP
CALDE

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ELECTRICAL REVIEW

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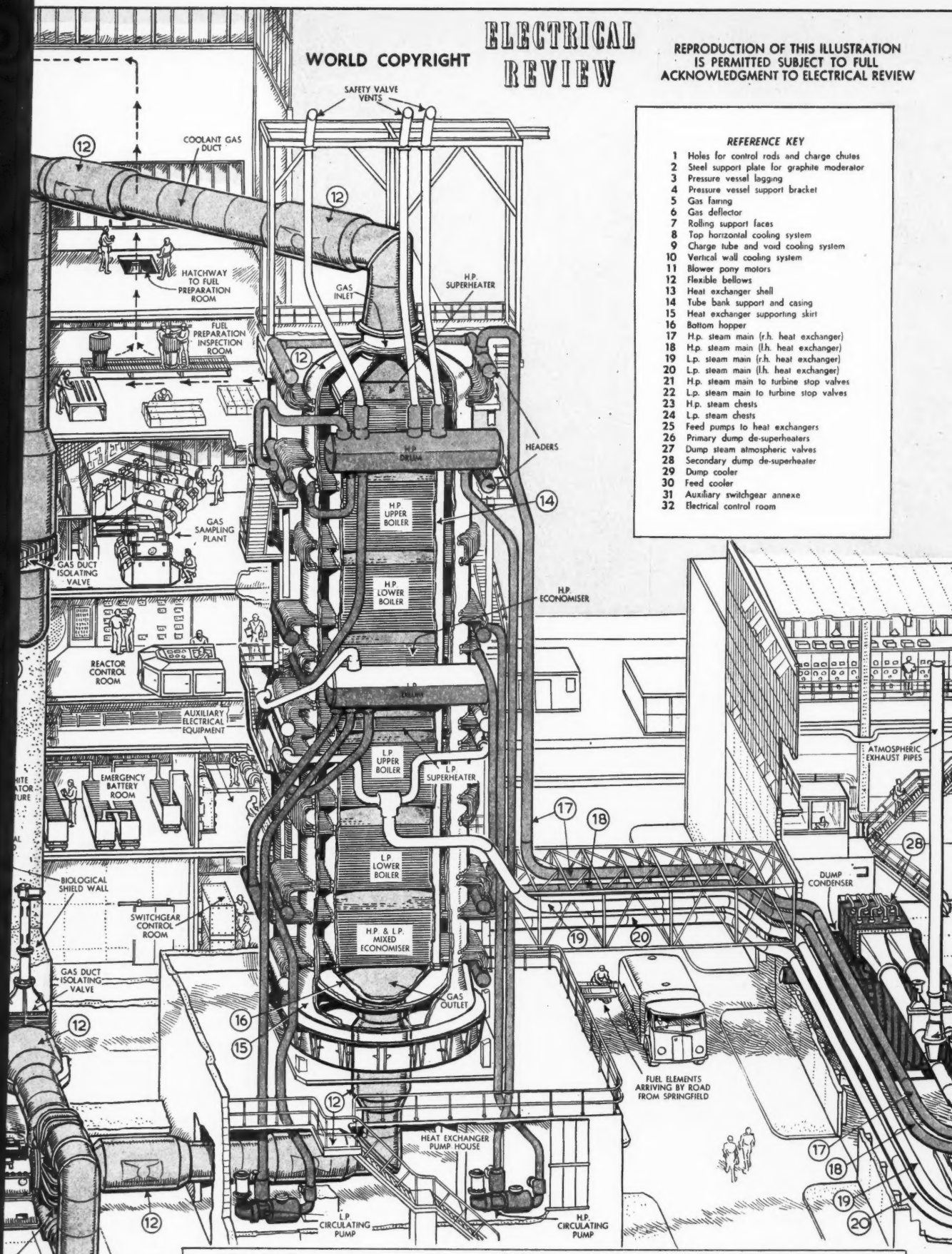


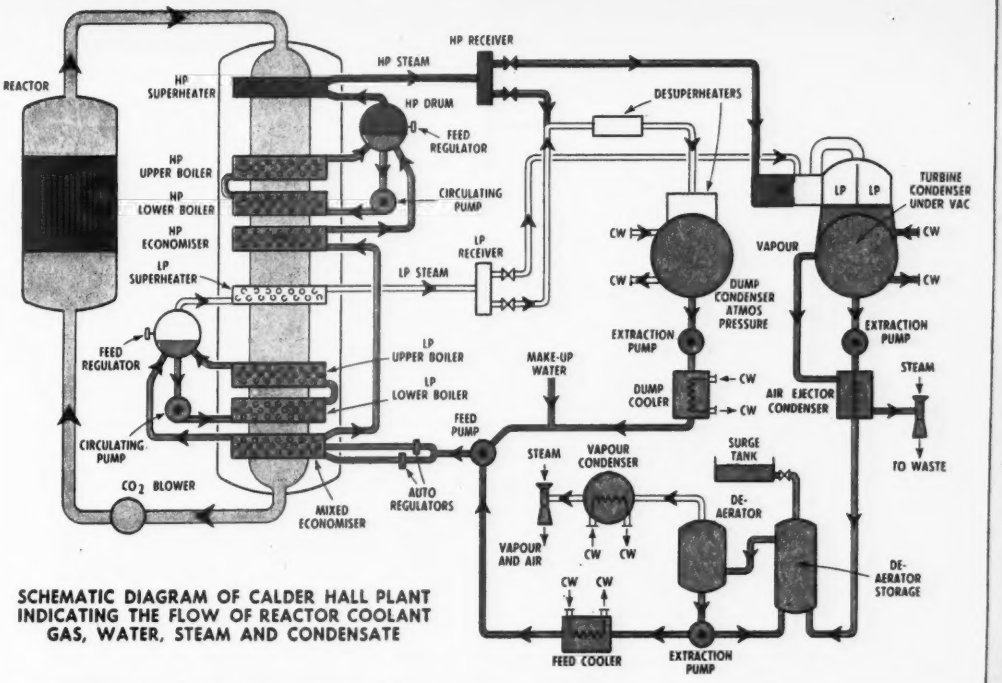
REFERENCE KEY

1 Holes for control rods and charge chutes
2 Steel support plate for graphite moderator
3 Pressure vessel lagging
4 Pressure vessel support bracket
5 Gas fairing
6 Gas deflector
7 Rolling support faces
8 Top horizontal cooling system
9 Charge tube and void cooling system
10 Vertical wall cooling system
11 Blower pony motors
12 Flexible bellows
13 Heat exchanger shell
14 Tube bank support and casing
15 Heat exchanger supporting skirt
16 Bottom hopper
17 H.p. steam main (r.h. heat exchanger)
18 H.p. steam main (l.h. heat exchanger)
19 L.p. steam main (r.h. heat exchanger)
20 L.p. steam main (l.h. heat exchanger)
21 H.p. steam main to turbine stop valves
22 L.p. steam main to turbine stop valves
23 H.p. steam chests
24 L.p. steam chests
25 Feed pumps to heat exchangers
26 Primary dump de-superheaters
27 Dump steam atmospheric valves
28 Secondary dump de-superheater
29 Dump cooler
30 Feed cooler
31 Auxiliary switchgear annexe
32 Electrical control room

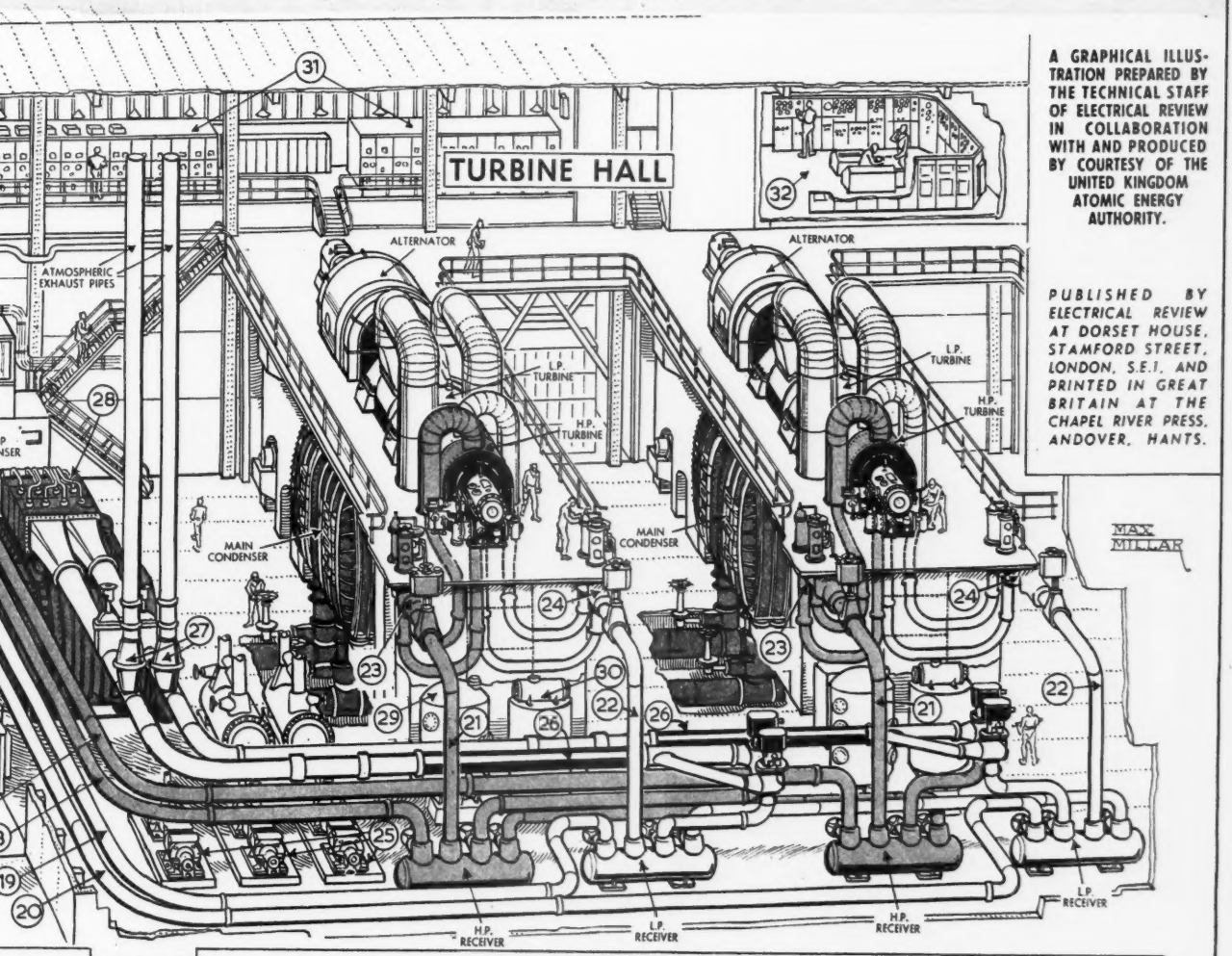
CALDER HALL NUCLEAR GENERATING STATION

SUPPLEMENT TO ELECTRICAL REVIEW, 19 OCTOBER, 1956

USTRATION
TO FULL
RICAL REVIEW



SCHEMATIC DIAGRAM OF CALDER HALL PLANT INDICATING THE FLOW OF REACTOR COOLANT GAS, WATER, STEAM AND CONDENSATE



DETAILED CONSTRUCTIONAL ARRANGEMENT OF REACTOR NO. 2 AND TWO OF ITS FOUR ASSOCIATED HEAT EXCHANGERS, TOGETHER WITH NOS. 3 AND 4 TURBO-ALTERNATORS AND ALL OF THE ESSENTIAL AUXILIARIES IN BOTH THE TURBINE HALL AND REACTOR BUILDING.

A GRAPHICAL ILLUSTRATION PREPARED BY THE TECHNICAL STAFF OF ELECTRICAL REVIEW IN COLLABORATION WITH AND PRODUCED BY COURTESY OF THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY.

PUBLISHED BY ELECTRICAL REVIEW AT DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1. AND PRINTED IN GREAT BRITAIN AT THE CHAPEL RIVER PRESS, ANDOVER, HANTS.

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operator the state of the grab, i.e. if it is open or closed, if it is in contact with a fuel element and whether or not a fuel element is being carried. Indication is also given of grab depth in the moderator block, of slack cable and of the magazine basket in the charging machine body. In the event of slack or over-taut cable the winch motor stops automatically and each machine is fully interlocked to prevent mal-operation.

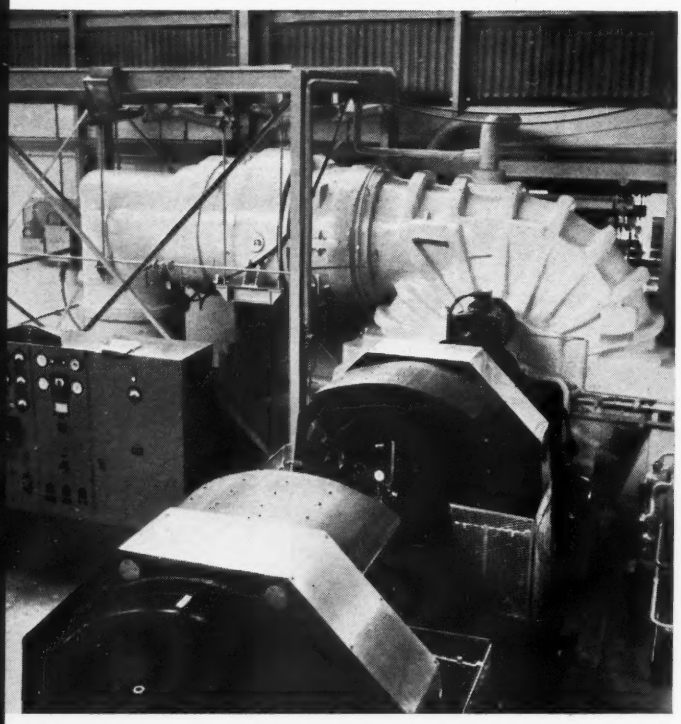
Similar machines are provided for discharge purposes, but unlike the charging machines they are provided with heavy thermal and biological shields and cannot be opened from the charge floor. This is because irradiated fuel elements are radioactive and also hot. To limit the temperature of the fuel elements to a safe figure while they are in the discharge machine a cooling system is incorporated in the design and this consists of a number of fans which circulate air through the container and an external heat exchanger. When the magazine basket inside a discharge machine is full of irradiated fuel elements it is moved across the charge floor to a position over the traverse pit. Here the traverser trolley is positioned for release of the bottom door of the charging machine by means of a hydraulic jack. The machine is then ready for discharging its basket which is lowered by winch down through the discharge well into the irradiated fuel container at ground level of the reactor building.

The irradiated fuel container is a lead-lined steel cylinder weighing about 30 tons and it is filled with water. When the magazine of irradiated fuel elements has been deposited in the container a lead-lined steel lid is placed in position by remote control, the operator viewing the proceedings through a permanently installed periscope. The container is then safe to handle and can be brought out into the open, loaded on to a suitable vehicle and transported to the Windscale factory. Here, the magazine basket is removed under water and the fuel elements are extracted. The basket and irradiated fuel container are returned to Calder Hall for re-use, while the fuel elements remain under water for some months before the process of chemical separation into plutonium, uranium and fission products is carried out. Since the reactor has to be shut down before either charging or discharging can take place, the normal procedure will be to charge and discharge fuel elements in bulk, say, about 35 tons at a time.

This apparatus is used to detect burst fuel elements by regular periodic sampling of the gases from the moderator channels

The nuclear reaction which takes place in the reactor is normally controlled and also shut off under emergency conditions by inserting rods of stainless steel tubing lined with boron steel fillers. Boron has a high neutron absorption cross-section and if the rods are fully inserted into the reactor core the nuclear reaction is stopped. By varying the amount of control rod in the reactor the rate of the nuclear reaction and the temperature of the core are varied.

No. 1 reactor control room showing the main control desk and some of the elaborate instrumentation



One of the four 2,200 h.p. blowers circulating the CO_2 heat transfer gas through No. 1 reactor and its four associated heat exchangers

The control rod mechanism consists essentially of an electrically driven winch for raising and lowering during normal operating conditions. To meet emergencies the arrangement incorporates an electromagnetic clutch which allows the rod to be dropped at will into the graphite core to cause an immediate shut down. The complete mechanism is accommodated within the reactor pressure vessel with electrical connections through the pressure casing by means of glass-to-metal seals. The individual rod positions are transmitted electrically to indicators on a mimic diagram in the reactor control room.

Overall control of the reactor is carried out from this room, which is on the second floor of the reactor building. There is a console type control desk in the centre facing the main control panels on which the temperature, gas and steam pressure and flow indicators are mounted in the form of a mimic diagram. From the control desk the operator can regulate the positions of the boron control rods in the graphite moderator block, also the CO_2 coolant blower speeds in accordance with gas temperature and steam output from the heat exchangers. An elaborate and costly system has been installed to facilitate the detection of burst fuel elements by regular periodic sampling of the gases from the moderator channels. Once detected the burst fuel element must be watched most carefully and dealt with according to the degree of burst in order that the whole reactor does not become contaminated with radioactive fission products. The control room also accommodates the instruments required for the measurement of the reactor activity, for control under normal operating conditions and for safety of the reactor in the event of any untoward trend of the activity level.

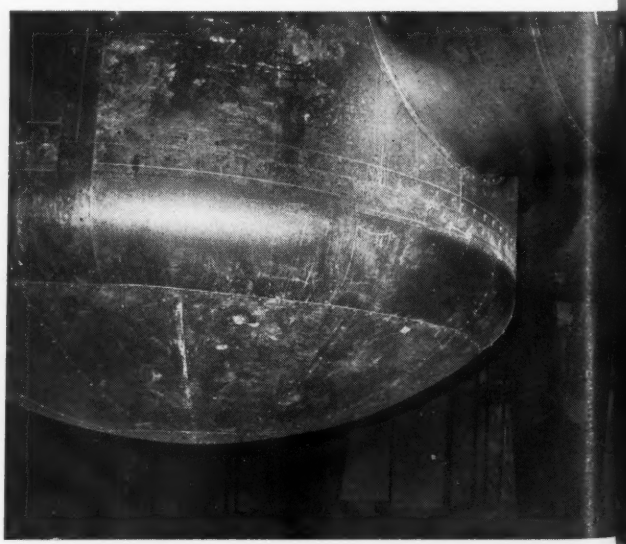
As already indicated, the hot CO_2 heat transfer medium leaves the top of the pressure vessel through mild steel ducts of 54in diameter and enters the tops of the four heat exchangers which are situated one at each corner of the reactor building. From the base of each heat exchanger the cool CO_2 is boosted by means of four main blowers and returned to the inlet manifold at the base of the reactor pressure vessel where this is of reduced diameter. In this section of reduced diameter an arrangement is incorporated to ensure that cool CO_2 gas streams from opposing inlet pipes do not meet in direct opposition and that one single blended stream of cool gas passes upwards through the core of the reactor. Motorised isolating valves of the wedge gate type are fitted in each hot and cold gas duct and flow cascades are incorporated in the bends in the ducts. The large thermal expansions which take place between the pressure vessel and heat exchangers are dealt with by hinged bellows in the ducts. The duct flexibility is obtained from the bellows, which are fabricated from steel plate, while the thrust due to the internal gas pressure is taken by the pin joint in the bellows assembly. The whole of the duct structures are carried on spring-type constant load supports.

Reactor Coolant Circulation

The four CO_2 blowers are of the single-stage centrifugal type with an overhung impeller. The mass flow of CO_2 (normally 1,964 lb/sec at 100 lb/sq in and 284 deg F at the blower outlet) is controlled by varying the speed of the blowers. Each main drive motor is a direct-coupled 0/1,500/2,200 h.p. 0/854/940 r.p.m. d.c. machine arranged for Ward-Leonard control, the motor on the associated motor-generator set being a 2,500 b.h.p. 750 r.p.m. 11 kV machine arranged for direct-on-line starting. By means of this system the blower speed can be varied over a speed range of 10:1. Roughly 2 per cent of the mass flow through each of the four blowers is taken from the downstream side of the blower, filtered and reintroduced into the system on the upstream side of the blower to prevent the accumulation of graphite dust and iron oxide in the gas system. Flowmeters are incorporated in all four heat exchanger gas circuits and motorised valves are fitted in all inlet and outlet gas ducts. This enables the four heat exchanger circuits to be trimmed to have equal steam outputs.

On top of each compressor driving motor is a 15 h.p. d.c. pony motor which is equipped with a manually operated

Cool CO_2 from the heat exchangers is boosted by four blowers and returned to the inlet manifold at the base of the reactor pressure vessel where this is of reduced diameter

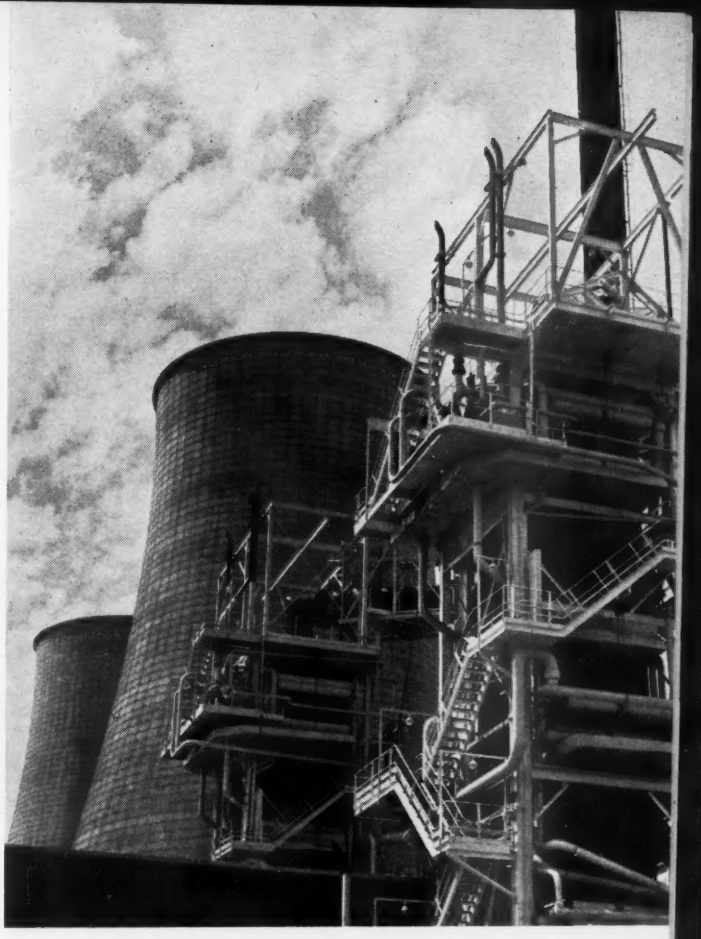


clutch connecting it to the blower driving shaft. The pony is used for starting-up purposes to get the CO_2 moving round the circuit. Once this has been done the pony clutch is disengaged and the main Ward-Leonard drive brought into service. Arrangements are made whereby if the speed of the Ward-Leonard drive falls below 150 r.p.m. (say, due to interruption of the a.c. supply) an auxiliary d.c. supply system consisting of a 2,000 Ah 240/330 V battery and two 500 kW 600 r.p.m. diesel generating sets is brought into service in conjunction with the pony motor.

Altogether there are 25 tons of CO_2 gas in the reactor cooling circuit at a pressure of 100 lb/sq in throughout; the temperatures at the lower and upper ends of the reactor pressure vessel are 140 deg C and 336 deg C respectively. No radioactivity is transferred from the reactor to the water and steam in the heat exchangers and turbines. This is because the CO_2 coolant becomes only very slightly radioactive and in any case such activity as there is decays very rapidly. The high neutron absorption cross-section of the tube banks in the heat exchangers further guards against any activity being present in the steam and water circuits.

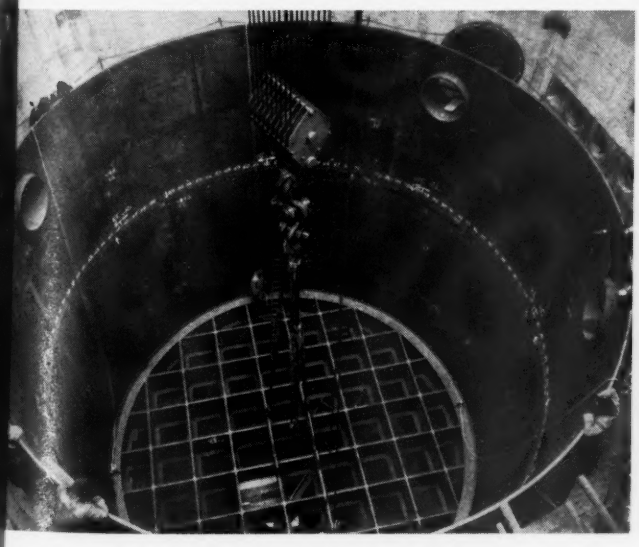
To provide for the charging of the reactor and heat exchanger gas circuit and also the make-up of any losses which may occur, a CO_2 storage building has been erected to the west of the turbine hall and this serves both reactors of the "A" station. Liquid CO_2 is delivered to this building by road tankers and stored in four 4 ton tanks under a pressure of 350 lb/sq in. The liquid CO_2 is evaporated before being fed into a permanent pipeline installation to the reactor blower houses where it is introduced into the cooling systems at 150 lb/sq in as and when required. The CO_2 is kept in a liquid state by local refrigerators using "Freon" as the refrigerant.

Each of the four heat exchangers associated with a reactor is an outer vertical steel pressure vessel, fabricated from $1\frac{5}{16}$in steel plate, 17ft 6in in diameter and about 70ft high, and this incorporates two separate sets of steam raising equipment with a combined total of nearly 100,000 sq ft of surface area for heat transfer. Thus, a dual pressure steam cycle is employed, the two conditions being 200 lb/sq in at 590 deg F and 53 lb/sq in at 340 deg F. When compared with a single pressure steam cycle the Calder Hall arrangement gives a gain in electrical output of roughly 12 per cent. The point is that in the case of a single pressure system the addition of heating surface above a certain amount is uneconomic whereas the dual pressure system justifies the addition of much more heating surface all of which is useful. The dual pressure steam cycle also has the advantage of facilitating close regulation of reactor coolant temperature which is important since it minimises the temperature stresses due to plant changes and emergency conditions such as alternator trip-out.



Close-up of one of the four heat exchangers associated with No. 1 reactor

Here the 63 ton diagrid which supports the graphite core of the reactor is being lowered into position. The hot CO_2 will leave the vessel through the four 54in diameter holes seen towards the top



When the plant is working the low-pressure sections of the heat exchangers are operated at variable pressure. They are called upon to generate steam at very low pressure when the station load is at the maximum and at their highest pressure when the station load is the minimum. Under the latter condition the steam pressures in both high- and low-pressure sections of the heat exchangers are almost equal. The effect of allowing the pressure of the l.p. system to increase as the station load falls is, conveniently, to prevent the reactor coolant inlet temperature from falling.

The dual pressure steam cycle, in conjunction with the variable speed drive of the coolant blowers, enables the coolant temperature both at the reactor inlet and outlet to be maintained constant irrespective of load, or, alternatively, to be pre-set at such other levels as are calculated to minimise transient temperature stresses in the plant. Furthermore, the flow of l.p. steam from the heat exchangers to the turbine hall can be regulated by means of oil-operated valves on the steam mains into the steam receivers in the turbine hall basement. This is effected by means of a bias control system in conjunction with the oil-operated valves which are equipped with Magslip indication back to the reactor control room. If it is so

desired these valves can be adjusted locally although under normal conditions of operation the flow of l.p. steam will be governed by the reactor operations staff.

Altogether each heat exchanger contains eight banks of tubing represented by a combined h.p. and l.p. economiser, lower and upper l.p. evaporator, l.p. superheater, h.p. economiser, lower and upper h.p. evaporator, and h.p. superheater. The two superheaters are made from plain tubing whereas in the case of all other sections the gas heating surface is extended by means of elliptical steel studs which are flash-welded to the tubes and have smooth surfaces and a profile giving good aerodynamic properties. Altogether there is a total of about ten million studs in the four heat exchangers associated with each reactor. An important requirement of the internal heating surface is that there should be no leakage of steam or water into the coolant gas, otherwise contamination of the internal components of the reactor would result. Thus, the design of the heat exchangers involves no joints inside the pressure vessels, except those which, once completed and exhaustively tested in the contractors' works, will not be required to be broken throughout the anticipated life of the plant.

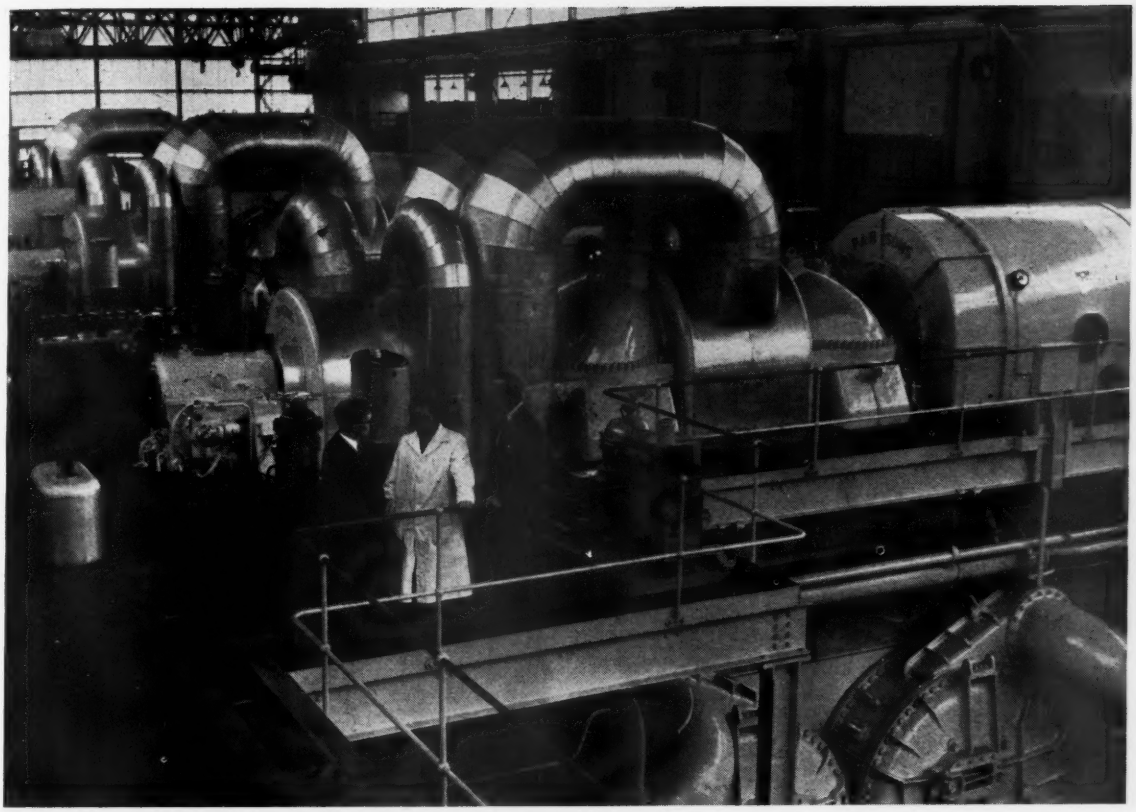
Heat Exchanger Problems

The manufacture and erection of the heat exchangers has presented many unusual problems in that the procedures adopted in normal boiler practice could not be employed largely because of the necessity for extreme cleanliness in the interior of the vessel. The shell of the vessel is fabricated horizontally and once it is raised into its final vertical position on site the interior is shot blasted and thoroughly cleaned. The bottom of the vessel is then sealed and all men and materials enter via a cleaning house temporarily erected on top of the upper flange of the exchanger. All site welds are then carried out outside the vessel, the tube banks protruding through nozzles which are seal welded and subsequently pressure tested using a CO_2 leak detecting device.

Flow of water in the two evaporator sections of the heat exchangers is by forced circulation from electrically driven pumps which maintain a circulation rate of about four times the steam output of the section. The primary circulation pump on the l.p. side is a single-stage centrifugal unit driven by an 18 h.p. induction motor, while there is also a standby pump of the glandless water-cooled type driven by a 15 h.p. induction motor. The h.p. evaporator side is served by similar pumps, in this case driven by 45 h.p. and 40 h.p. induction motors respectively. Each evaporator is equipped with a single steam drum 18ft long and of 4ft diameter which incorporates conventional cyclones and scrubbers. The h.p. drums have three safety valves set to operate at 240, 245 and 250 lb/sq in respectively, while the l.p. drum has two safety valves which will blow at 170 and 180 lb/sq in.

From the steam drums via the superheaters a system of overhead pipes carries the steam to the turbine building. The four heat exchangers associated with each reactor are coupled together in pairs to deliver steam through common manifolds running over a trestle bridge to the h.p. and l.p. steam receivers in the turbine hall basement. Thus, there are two l.p. and two h.p. steam mains from each reactor, each feeding a steam receiver in the turbine hall. The arrangement is such that two heat exchangers and one

Basement of the turbine building showing the feed water de-aerators, steam receivers, a de-superheater and the feed cooler for No. 1 reactor heat exchangers



The turbine room accommodates four 23 MW 3,000 r.p.m. turbo-alternators operating on a dual pressure steam cycle

turbo-alternator set operate as a single unit, although the two units can be interconnected to give flexibility of control.

In the turbine building there are four 23 MW 3,000 r.p.m. turbo-alternators and their associated surface condensing plant, main de-aerators and de-superheaters, and two dump condensers. Generally speaking, this plant is of conventional design but as it is working in conjunction with slow nuclear reactors some special features have been incorporated.

Dump Condensers

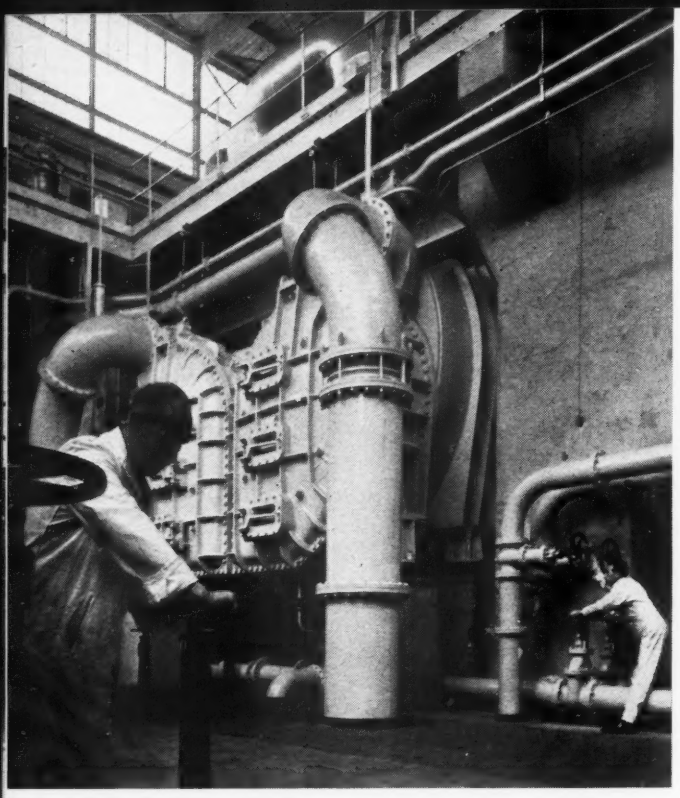
As already explained the nuclear reactors release heat energy to a battery of heat exchangers which constitute the h.p. and l.p. boilers, economisers and superheaters and the steam raised within the heat exchangers is, under normal conditions, fed to the turbines driving the generators. As the output of the nuclear reactor must be absorbed at all times, irrespective of electrical output requirements, surplus steam from the heat exchangers can be relieved automatically to the dump condensers, even when all the turbo-alternators are out of commission. Full protection and automatic interlocking of essential parts have been introduced to maintain the continuity of output from the nuclear reactors since the production of plutonium and not the generation of electricity is the primary consideration.

Normally, the station will operate with two distinct major units, both turbines of each unit equally sharing the load under steam pressure control, with one alternator feeding the auxiliaries of a Calder Hall reactor and the Central Electricity Authority's grid and the other alternator feeding Windscale and the C.E.A. grid.

Each of the four 3,000 r.p.m. turbines consists of a single axial flow reaction type h.p. cylinder with 22 stages and a double-flow reaction type l.p. cylinder with six stages in each half. The bottom sections of the h.p. and l.p. cylinders are solidly connected and supported on common foundations in such a manner as to maintain good alignment under all conditions of loading. The h.p. and l.p. turbine rotors and the alternator rotor are solidly coupled so that only one thrust bearing is required to take the out-of-balance thrust of the complete unit.

Steam from the h.p. and l.p. manifolds, which are interconnected with the steam receivers fed by the heat exchangers, enters the turbine through h.p. and l.p. steam chests disposed on opposite sides of and co-axially with the h.p. cylinder and each containing an emergency stop valve and a governor valve. The h.p. steam conditions at the turbine stop valve are 200 lb/sq in and 590 deg F, while the l.p. steam, which enters the machine after the fifteenth stage, is at 53 lb/sq in and 340 deg F at the stop valve. The turbine can operate either under speed governor control or steam pressure control. The h.p. and l.p. governor valves, emergency stop valves and the steam pressure regulator are operated by power oil supplied by a gear type oil pump mounted on a cross shaft driven by worm-gearing from the steam end of the h.p. turbine shaft. A lubricating oil pump supplying oil to the oil coolers and bearings is mounted on the same cross shaft.

From the turbine steam exhausts into a three-pass divided water box condenser with a total cooling surface of 32,500 sq ft and a cooling water requirement of 22,500 gal/min at 70 deg F; the vacuum is 1·75in Hg and the condensate leaves at 96·6 deg F. The condenser cooling system has been designed so that in the event of failure of one of the cooling water mains the turbo-alternators can still be kept running, but at reduced load.



From each turbine steam exhausts into a three-pass divided water box condenser with a total cooling surface of 32,500 sq ft

As already indicated, surplus steam from the heat exchangers can be relieved automatically into the dump mains. In these mains there are atmospheric valves capable of handling the maximum steam flow likely to occur under extreme conditions. When these valves operate and relieve steam to atmosphere indication is given to the operating staff who can then commission the dump condensers. These condensers are situated at ground level one at either end of the turbine house adjacent to the condensers associated with Nos. 1 and 4 turbo-alternator sets. They are two-pass units each with a total cooling surface of 12,000 sq ft and a circulating water requirement of 25,000 gal/min. With c.w. inlet and outlet temperatures of 70 deg F and 108·5 deg F respectively, each dump condenser can deal with steam at the rate of 514,600 lb/hr. The dump condensers are used not only when the turbines are shut down but also when a reactor is being started up since in the initial stages the steam generated in the heat exchangers is of such a low value that it cannot in any circumstances be put through a turbine.

The steam pipes serving the dump condenser are connected in parallel with the steam pipes serving the main turbines, from common steam receivers, the steam to the dump condensers passing through h.p. and l.p. dump valves which are automatically operated by servo-motors employing steam relays controlling a supply of power operating oil. Primary tubular de-superheaters are installed in the common steam lines to the dump condenser to reduce the steam temperature, volume and speed to reasonable proportions before it enters the upper chamber of the dump condenser, where banks of secondary de-superheater nozzles are fitted to remove the last traces of superheat and render the steam suitable for condensing under atmospheric conditions.

Two cold water de-aerators operating on the recirculating principle and working in parallel are capable of handling the full output of two turbo-alternator units or one dump condenser, and they are arranged so that all the feed water required under all conditions of loading will pass through them. All the feed water entering the de-aerators passes through large capacity sealed storage tanks which are connected by balance legs to the overhead surge tanks. The feed water is flashed into the de-aerator through a series of spray nozzles at the vacuum corresponding to the discharge temperature of the feed water.

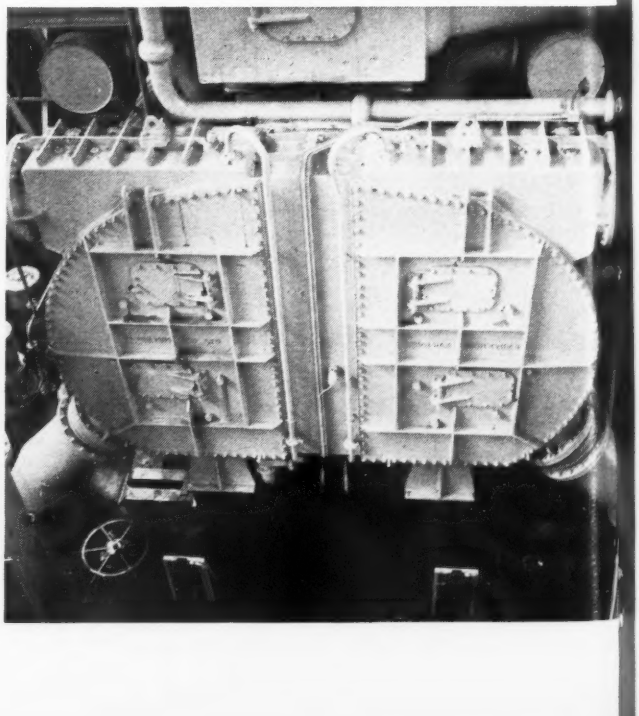
The vacuum in the de-aerator vessel is maintained by a two-stage ejector unit fitted with a horizontal tubular pre-cooler and inter-cooler, which withdraws and discharges to atmosphere any gases liberated in the de-aerator. The operating steam of the primary ejector, together with any further vapour condensed in the tubular coolers, is returned to the system. The de-aerated water drawn from the base of the de-aerator is discharged by the extraction pump to a feed cooler and as the capacity of the de-aerator and extraction pump is in excess of normal feed requirements, a proportion of de-aerated water is recirculated continuously through the storage vessel.

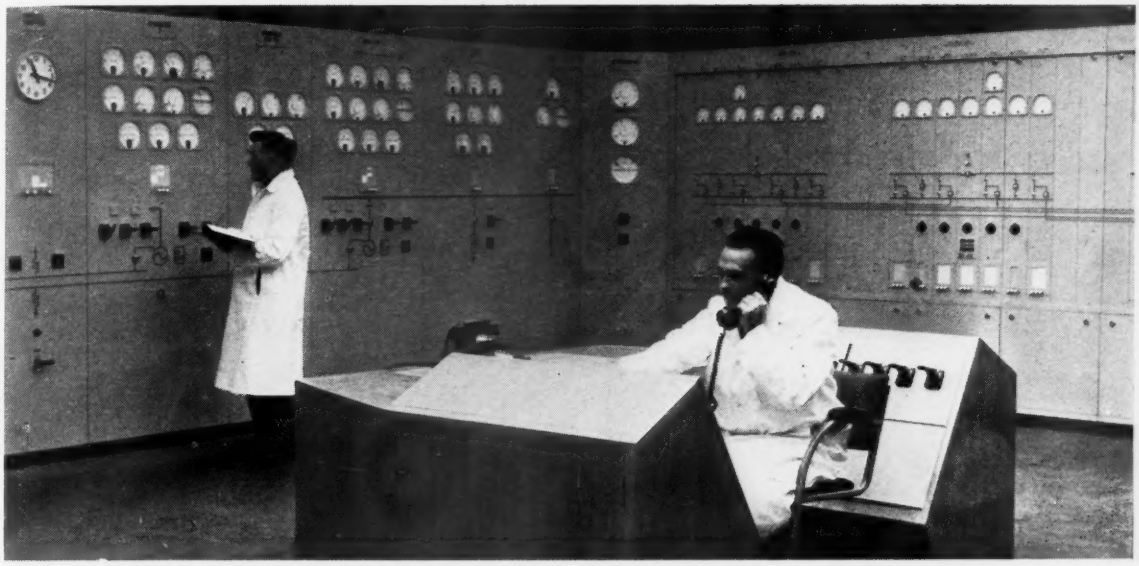
Condensate and Feed System

To understand the operation of the condensate and feed water system reference is necessary to the schematic flow diagram incorporated in our inset illustration. The condensate delivered by the dump condenser extraction pumps, which are rated at 350,000 lb/hr with a discharge head of 66ft, passes first through twin strainers and then through the float-operated condensate valve where the flow is controlled to maintain a constant water level in the condenser hot well. Next, the condensate passes through a venturi tube forming part of the flow metering equipment and then through the dump condensate cooler where its temperature can be reduced from 212 deg F to 100 deg F, or whatever figure is required. After leaving the dump cooler the condensate passes to the main feed suction line.

The condensate delivered by the main condenser extraction pumps, of which there are two 100 per cent duty single-stage vertical units for each condenser, passes through float-operated condensate valves controlling the flow to maintain constant water levels in the hot wells. It then passes through the air ejectors, where it reclaims a high proportion of the heat from the ejector steam supply,

Each dump condenser is able to deal with surplus steam at the rate of 514,600 lb/hr





Control of the generators is from the main electrical control room adjacent to the turbine building

and then through venturi tubes forming part of the flow metering equipment on its way to the main feed suction line.

The pressure in the main feed suction line is kept reasonably constant and the oxygen content of the feed water is reduced to the minimum value as all the feed passes through the de-aerating plant, the storage vessels of which are directly connected up to a balance main giving access to the overhead feed water tanks. All of the feed water from the dump condenser and the main condensers passes through a feed cooler where its temperature can be adjusted to meet operating requirements before it enters the feed pump suction line. Make-up water to the feed system can be obtained from two sources. Firstly, there is a supply from the de-mineralisation plant which enters either the clean drain tank through a ball float operated valve or the make-up de-aerator and then to the feed main supplying the main de-aerators. Secondly, there is a supply from the overhead feed water surge tanks, which enters the de-aerator storage tank through a 6in balance pipe.

For each half of the station, which houses two turbo-alternator sets and one dump condenser, there are four electrically driven feed pumps, three a.c. units and one d.c. standby pump. The three main pumps are 100 per cent duty multi-stage horizontal units driven by 210 h.p. 3·3 kV induction motors and capable of delivering feed at the rate of 350,000 lb/hr against a head of 758ft. The d.c. standby pump is driven by an 18 h.p. 250 V d.c. machine and is capable of delivering about 130,000 lb/hr of feed to the boilers at 225 lb/sq in. Under normal conditions of service only two a.c. feed pumps are in operation and provision is made for the third unit to act as standby so that a fall in pressure in the h.p. feed lines would automatically bring it into service. As a precaution there are two feed mains to the heat exchangers and each is capable of handling the maximum feed requirements of four units.

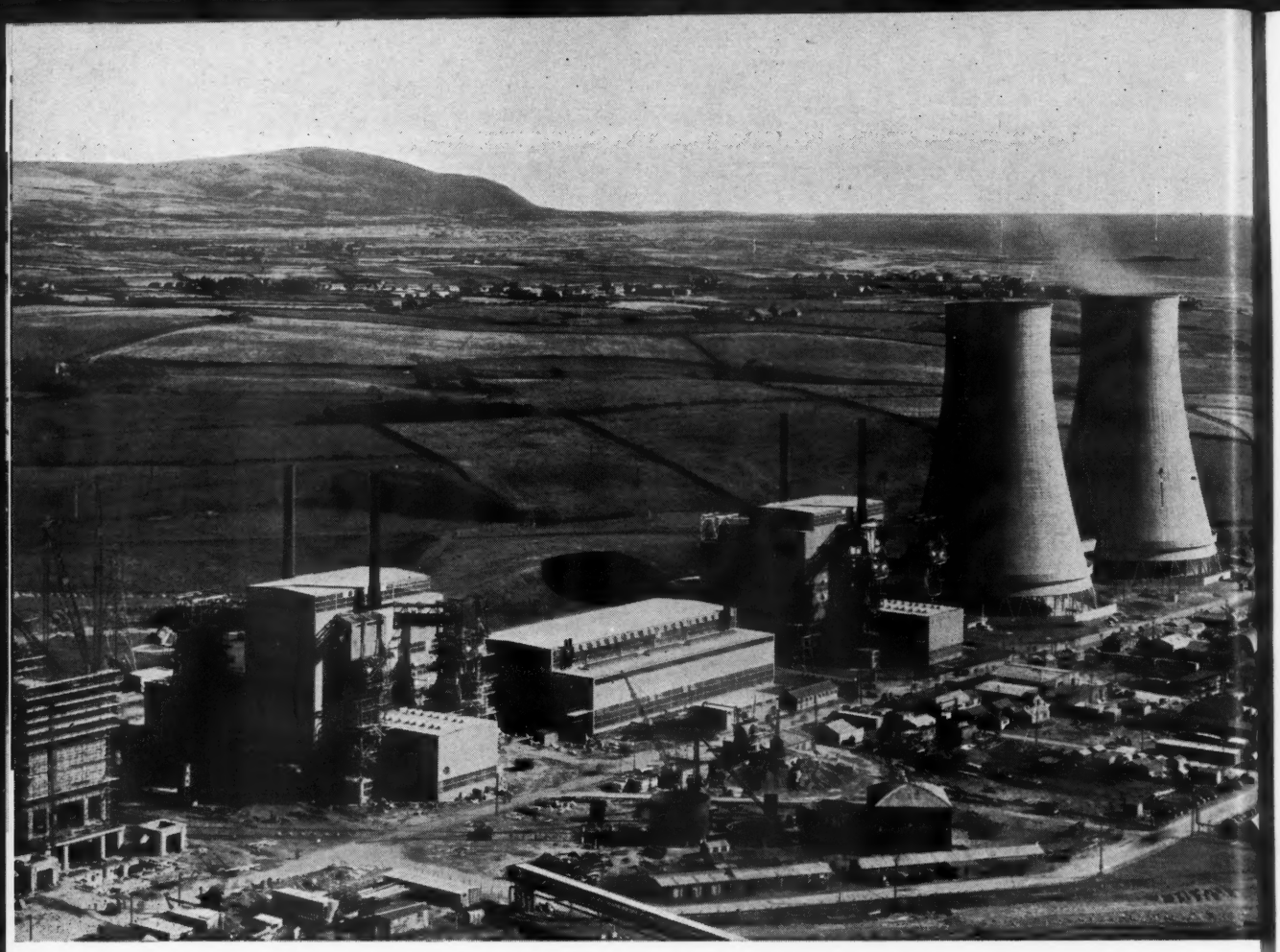
From the feed pumps the feed water line bifurcates to supply the h.p. and l.p. sections of the heat exchangers respectively through suitable regulators. For cooling the condensers a closed circuit cooling water system is employed with two cooling towers each of which is 290ft high, 200ft in diameter at the ring beam and with a throat diameter of 104ft; each tower is capable of handling 3,000,000 gal/hr. From No. 2 tower there are two 42in diameter mains to a suction sump situated alongside the main c.w. pumphouse. These mains pass underneath No. 1 tower, which is also connected to the sump but by an open concrete channel. In the pumphouse there are five single-stage horizontal type centrifugal c.w. pumps, driven by squirrel cage induction motors to deliver 25,000 gal/min against a 70ft head. These feed the condensers via two 60in diameter underground mains connected to further mains running the length of the turbine room basement. The two return mains from the condensers join into the interconnector between the two towers by means of 60in underground mains. As mentioned earlier, supplies of water for c.w. make-up purposes are obtained from Wast Water through an 18in diameter main.

Generating Plant

The electrical output of Calder Hall " A " is from four alternators each of 23 MW continuous maximum rating at a power factor of 0·8 lagging. The alternators are of a conventional 3,000 r.p.m. two-pole design arranged for forced-air cooling, the generated voltage being 11·5 kV. Excitation is from direct-coupled air-cooled exciters and pilot exciters in common frames.

The terminals of each machine are connected by means of copper bars in the alternator pits to cable sealing ends and then each machine is cabled to the 11 kV switchgear. The neutral of each machine is earthed either by means of an earthing transformer and resistance connected to the 11 kV side of the associated grid transformer, or, alternatively, through an earthing circuit-breaker and resistance to an earth point adjacent to the turbine hall; this latter earthing is for use only when running independently of the C.E.A. grid system and supplying Calder Works and Windscale Works only.

Generators 1 and 4 are each connected to a three-switch substation consisting of 500 MVA rupturing capacity oil-break horizontal draw-out circuit-breakers. The three switches control the generator, the grid transformer and the 11 kV feed to nuclear reactor No. 1 or nuclear reactor No. 2 respectively. The feed to each reactor is through a 30 MVA current-limiting reactor to 350 MVA rupturing capacity switchgear in the reactor switch rooms. The two three-switch substations are adjacent to each other underneath the control block building at Calder " A."



Calder Hall "A" generating station complete with its two cooling towers. Construction work is proceeding on the first reactor of the "B" station to the left

Generators 2 and 3 are connected to a substation situated adjacent to the Windscale Works about half a mile away. Here, the switchgear is in two sections with a section switch, and each half consists of three 750 MVA switches for the generator, grid transformer, and in this case the Windscale pile 11 kV supplies. This switchgear is similar to that at Calder Hall, apart from its higher rupturing capacity. Normally, the station will operate with two distinct major units, both turbines of each unit equally sharing the load under steam pressure control, with one alternator feeding a Calder Hall reactor and the C.E.A. grid and the other alternator feeding Windscale and the C.E.A. grid.

Control of the generators is from the main electrical control room which is situated between the administration block and the turbine hall, and contains a main row of control panels for the control of the generator 11 kV switchgear and of the Calder grid transformers and nuclear reactor 1 and 2 switches. These panels are of the corridor type with protective relays at the back portion. Each panel has associated with it on its relay panel a voltage regulator of the acquiescent type and a low excitation limiting relay to safeguard the system against instability. Certain of the controls are repeated on the desk, which is situated in the centre of the control room. On either side of the main control panels are miniature panels with controls for the circuit-breakers on the 132 kV side of the grid transformers, the remote substation 11 kV switches for the grid transformers feeding the Windscale piles, and for the 3·3 kV feeds to the cooling water pumphouse. Indication of conditions in the pumphouse are also given.

Acknowledgment is due to the United Kingdom Atomic Energy Authority for permission to publish this article, and also to Mr. A. Young, M.I.Mech.E., resident engineer, and his staff for invaluable assistance in the preparation of the material.

The following are the major contractors who have contributed towards the construction of Calder Hall "A" generating station:—Accles & Pollock, Ltd., Aiton & Co., Ltd., Babcock & Wilcox, Ltd., N. G. Bailey & Co., Ltd., J. Blakeborough & Sons, Ltd., British Acheson Electrodes, Ltd., British Insulated Callender's Cables, Ltd., British Thomson-Houston Co., Ltd., Cable Jointers, Ltd., Carbon Dioxide Co., Chatwood Safe & Engineering Co., Chesterfield Tube Co., Ltd., Chloride Batteries, Ltd., Colvilles, Ltd., Consett Iron & Steel Co., Ltd., Costain-John Brown, Ltd., Crossley Bros., Ltd., Darlington Insulation Co., Ltd., Dewrance & Co., Ltd., Electric Furnace Co., Ltd., English Electric Co., Ltd., English Steel Corporation, Ltd., Fairey Aviation Co., Ltd., Alexander Findlay & Co., Ltd., General Electric Co., Ltd., Matthew Hall & Co., Ltd., Hopkinsons, Ltd., R. Jenkins & Co., Ltd., George Kent, Ltd., Lloyd's Register of Shipping, Marston-Excelsior, Ltd., Mather & Platt, Ltd., Metropolitan-Vickers Electrical Co., Ltd., New Western (Engineering), Ltd., Parolle Electrical Plant Co., Ltd., C. A. Parsons & Co., Ltd., Plessey Co., Ltd., Pollard Bearings, Ltd., A. Reyrolle & Co., Ltd., Shaw McInnes, Ltd., Steel Company of Wales, Ltd., Stewarts & Lloyds, Ltd., Strachan & Henshaw, Ltd., Talbot-Stead Tube Co., Ltd., Taylor Woodrow Construction, Ltd., Wharton Crane & Hoist Co., Ltd., and Whessoe, Ltd.

Fundamentals of Nuclear Power

Simplified Explanation of the Fission Process

ESSENTIALLY, an atom is a miniature solar system in which negatively charged electrons rotate in orbits around a positively charged nucleus. The total negative charge of the electrons is equal to the total positive charge of the nucleus, so that the atom as a whole exhibits zero charge. The nucleus consists of elementary particles called protons and neutrons; the protons carry the positive charge and the neutrons are neutral. Protons and neutrons have almost the same mass, which is 1,840 times the mass of an electron; the number of protons and neutrons in the nucleus thus determine almost completely the atomic weight of the element.

We often refer to two types of uranium, symbolised by 92U238 and 92U235. Each of these atoms has 92 protons in its nucleus, thus ensuring that their chemical properties are identical, but in the former case the nucleus is composed of 238 (neutrons+protons), whereas in the latter case there are only 235 (neutrons+protons). Both uranium atoms occur in natural uranium in the fixed ratio of 99·28 per cent U238 atoms and 0·72 per cent U235 atoms. The ratio of U238 to U235 atoms in uranium used for reactor fuel is most important and it would be surprising if the optimum ratio for a reactor was the same as that occurring in nature. In fact it is not and much of the early work on reactors was devoted to making reactors work on natural uranium, the only fuel available.

The atoms or molecules of any medium move about with an average kinetic energy determined by the prevailing temperature; this is known as the thermal energy. When the nucleus of a U235 atom is struck by a neutron having thermal energy there is a high probability that the nucleus will split into two parts (called " fission ") and the two new nuclei thus formed move off with great kinetic energy. The total kinetic energy of the two fission products is about 160 MeV (256×10^{16} erg) and this is rapidly dissipated in the surrounding fuel, with a consequent rise in the uranium temperature. The art of reactor design is taking this heat out of the fuel and delivering it for use in a thermodynamic heat cycle.

In fission an average of 2·5 neutrons are also freed from the nucleus, and these have energy far above thermal values. At ordinary temperatures thermal energy is about 1/40 eV whereas " fission " neutrons have an energy of about 1 MeV. If, on the average, one of these thermal neutrons enters into further fission then the process, once started, is a continuous " chain reaction." If more than one neutron causes fission the number of neutrons and fissions grows, but if less than one (on the average) causes fission the process dies out. The reactor designer must make all these events possible, and thus be able to control his reactor. The processes are illustrated in Fig. 1.

When discussing the fission of U235 we mentioned neutrons of thermal energy. It is important to be clear on what happens with neutrons of other energies and also consider the possibility of fission of the more abundant U238. A neutron colliding with a uranium nucleus may be merely diverted along a new path with decreased energy (called scattering) or it may be absorbed into the nucleus to cause fission, or it may be absorbed without fission. We must consider the probabilities of any of these processes

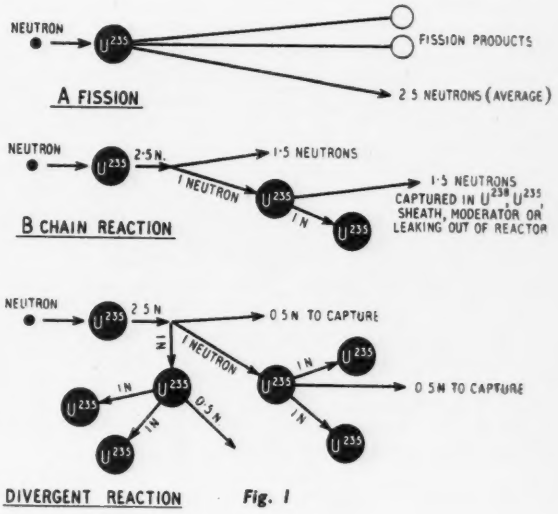


Fig. 1

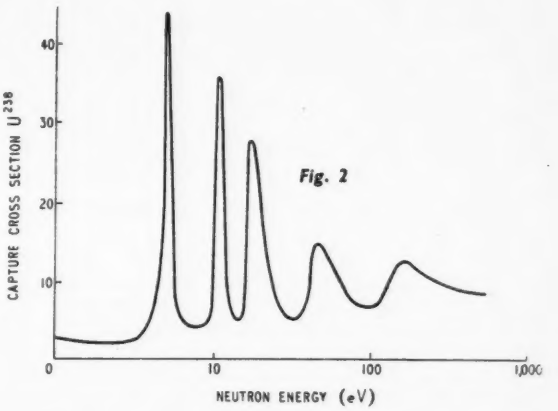


Fig. 2

occurring. This probability is expressed in terms of " cross-sections," having the units of area. A cross-section for any process is that area, surrounding a nucleus, which if the neutron enters will almost certainly lead to the event occurring. There are cross-sections for scattering, fission, and non-productive absorption (without fission) called " capture." In the above table the various cross-sections for the uranium isotopes are quoted in terms of neutron energy; see also Fig. 2.

Let us consider a nuclear reactor of natural uranium only and assume that a fission has occurred and that fission neutrons are released. These are " fast neutrons " and the table indicates that the probability is about 100:1 in favour of a fast neutron being scattered by a nucleus rather than of entering into fission with it. Scattering of the neutrons would predominate until the neutron energy was reduced to the range 1-20 eV. In this energy region U238

has very large cross-sections for unproductive capture, and is referred to as the " resonance " region. In our reactor, resonance capture of the fission neutrons would occur and none would be available to propagate the chain reaction. Thus the reactor consisting only of a block of natural uranium is not likely to be of much use. There are two ways of modifying this reactor, which will lead to a chain reaction being set in motion.

Firstly, the natural uranium can be " enriched " with U235, which has higher probability of fission with fast neutrons than U238, and if the proportion of U235 is high enough a reactor can be made to operate very well. Such a reactor is known as a fast reactor, since it operates on fast neutrons. Examples of such reactors are " Zephyr," at Harwell and the projected power reactor at Dounreay.

Secondly, the reactor can be provided with a " moderator " to slow the neutrons down below the resonance levels to thermal energies, where there is a strong probability of fission taking place when a neutron collides with the U235 nucleus. However, the table shows that at thermal energies it is only the U235 nucleus which is fissionable by neutrons and that the more abundant U238 atoms provide only unproductive capture. Because of the large fission cross-section of U235 a chain reaction becomes possible, despite some unproductive capture in both U238 and U235. To make a chain reaction possible extra material must be added to the reactor for moderation purposes, but it must capture very few neutrons. Such captures would be useless so far as the chain reaction is concerned. Apart from having low capture qualities the moderator should reduce the neutron energy to thermal levels very rapidly, to lessen the chances of the neutron colliding with a U238 nucleus while its energy is in the resonance region. To satisfy this requirement the moderator should be of low atomic weight, which reduces the list of possible moderators to ordinary water, heavy water, beryllium and carbon or graphite. Heavy water and beryllium are scarce and expensive, while ordinary water has a high absorption cross-section because of its hydrogen content. BEPO at Harwell, the production piles at Windscale, and the Calder Hall reactors use high purity graphite for moderation purposes.

Reactors in which the neutrons are moderated down to thermal levels before causing fission are called thermal reactors. In this country they have always been of the heterogeneous type, wherein cylindrical fuel rods about 1in in diameter are placed in a lattice arrangement. The reactor core consists of a stack of graphite blocks, through which the natural uranium fuel elements run, being usually placed about 8in apart. Around each rod is an annular space through which cooling gases can be pumped to remove the heat generated in the fuel rods. The complete core is usually a right cylinder, of length and diameter about 20-30ft, and may contain about 1,000 fuel element channels. After a period of operation the fuel rods, in addition to having uranium atoms, will contain many foreign atoms created in the fission process. Most of these fission products are highly radioactive and emit β particles or γ rays. To contain the fission products within the fuel element it must be enclosed completely in a sheath, which, however, should absorb as few neutrons as possible. In the Calder Hall reactors magnesium alloy is used.

	U235	U238	Natural Uranium
Cross-section for fission			
1 MeV	1·4	0·03	0·04
Thermal $\frac{1}{40}$ eV	580	0	3·92
Cross-section for Capture			
1 MeV	0·1	0·2	0·2
Thermal $\frac{1}{40}$ eV	107	2·8	3·5
Cross-section for Scattering			
1 MeV			4·0
Thermal $\frac{1}{40}$ eV	8·2	8·2	8·2

Cross-sections are given in barns. 1 barn = 1×10^{-24} sq cm

Considering neutron fates in the above reactor, we start at the stage where a number of fast neutrons are born through fissions in the fuel rod. Fast neutrons cause some fissions in U238 and U235, but in natural uranium they will not be sufficient to give a chain reaction; the fast neutron population will be slightly increased on this account. The neutron energies will be quickly reduced through collisions with uranium nuclei and if the resonance energies are reached the neutrons will be absorbed unproductively. Due to the finite size of the fuel rods, however, many neutrons will escape from the uranium before capture and will reach the graphite moderator, where their energy will be rapidly reduced to thermal levels without large risk of capture, because of the low cross-section of graphite. The thermal neutrons will now diffuse through the moderator and some will return to the fuel rods, but now at energies below the resonance regions, so that they are in a favourable condition for causing fission. If the dimensions of rod, moderator and lattice pitch are correct a chain reaction is possible.

" Critical " Size of Reactor

A complication arises, however, due to the finite size of our reactor. At the outer surface of the core neutrons can escape into space. Such neutrons would be lost to the chain reaction and because of this there is a minimum size for the type of reactor described, in which the chain reaction can possibly proceed. It must be such that enough excess neutrons are produced in the core to balance out the loss from the surface. This minimum, or " critical " size, can be reduced by surrounding the whole core by further graphite blocks, some 2 to 3ft thick. These act as a " reflector " in that some neutrons leaving the core are persuaded to return and take part in the chain reaction. The reflector gives a very worthwhile saving in the size of core required, and therefore of the amount of uranium fuel which has to be invested in the reactor.

A steady chain reaction can proceed if the number of neutrons available from each fission for further fissions is just unity. If the number is greater or less than unity the number of fissions occurring will rapidly increase or decrease. The heat produced in the reactor is directly proportional to the number of fissions occurring, and it is important that the latter should at all times be under control. This is accomplished by using neutron absorbing boron rods, which can be inserted or withdrawn from the reactor at will. If the reactor is large enough to be critical when the boron control rods are partly in, then their withdrawal will leave neutrons, which were previously being absorbed, for developing the chain reaction and the heat production or reactor power will increase. This increase will continue until additional absorber is inserted into the reactor to mop up the neutrons in excess of those required to give a steady chain reaction. This can be done with the control rods, which must be pushed in until instrument readings indicate that the heat production is steady. The number of neutrons in the reactor, and therefore the number of fissions occurring, is now much higher than in the original condition. The power output also is at a higher level. The procedure for power increasing

consists of withdrawing control rods until the new power level is reached and then inserting them again to keep the power steady at that level. Power reductions can similarly be achieved by further insertion of the rods and then withdrawing them again when the new lower level has been achieved.

Heat is removed from the reactor by pumping gas through the core. The scrubbing action of the gas over the fuel elements promotes heat transfer by forced convection from the fuel element surface into the bulk of the gas. Other processes are also involved, in that heat is produced in all parts of the fuel element and that formed near the rod centre must be carried by conduction to the surface before it can be transferred to the gas. To do this a temperature gradient is automatically built up radially within the rod so that the maximum temperature is achieved on the rod axis, and there is a steady drop to the surface, sufficient to ensure all heat being carried outwards. A similar state of affairs occurs in the fuel element sheath. It is important to realise that the maximum fuel element temperature occurs on its axis and that between there and the sheath surface, presented to the gas stream, a significant drop must occur. In the Calder Hall type reactors this temperature drop is about 60 deg C.

It is essential for heat transference that a temperature difference shall exist between the sheath surface and the heat transfer gas, and the magnitude of this difference depends on the amount of heat being taken out and the type of coolant gas being used. For high thermal efficiency in the steam cycle attached to our reactor we require high coolant temperatures in the reactor, and for a given surface temperature this means that the temperature drop between it and the coolant must be as low as possible. Reactors at Calder Hall have CO_2 cooling. The heat transference from fuel element to gas is also assisted by providing the fuel elements with extended finning.

Either of two temperatures in the fuel element may be influential in determining the temperature levels in a reactor. The maximum temperature on the fuel element axis should be less than about 630 deg C, to prevent the uranium passing through a phase change which occurs near that temperature. The phase change involves a significant increase in volume which might lead to fracture of the fuel element. The other important temperature point is that of the sheath surface. This must be low enough to ensure sufficient mechanical strength in the sheath to contain the fuel element and its radioactive fission products.

At present, sheath temperature is the criterion for maximum temperatures in the reactor, but when better materials are found which will still maintain the low neutron absorption requirement, the limit is likely to be set by the maximum allowable temperature on the fuel rod axis. Present sheath temperature limits are about 400 deg C and allowing for drop between this and the heat transfer gas, CO_2 outlet temperatures are about 360 deg C. The gas coolant leaving the reactor core at the highest permissible temperature is taken to a conventional tubular heat exchanger and is there used for raising saturated or superheated steam for use in a conventional turbine plant.

Neutron absorption in U238 does not in general lead to fission, but to the formation of a new atom of plutonium. This metal is fissionable by slow neutrons and in fact has a higher fission cross-section for thermal neutrons than U235. This makes plutonium valuable in nuclear energy considerations. It also has a significant military value.

The reactors at Windscale are entirely for the production of plutonium. In such reactors any spare neutrons not required for the chain reaction are absorbed in U238 to give plutonium and at intervals the fuel elements are removed from the reactor and the plutonium recovered by chemical processing. The production of plutonium at Calder Hall has received much consideration and in the design not all the emphasis has been placed on attaining the best thermodynamic and economic conditions for the production of electricity. In subsequent nuclear energy plants using similar reactors to the Calder Hall ones, the emphasis will be shifted away from plutonium production to more economic power generation.

[The above material is an abridged version of an article by Mr. D. V. Wordsworth which was originally published in our issue dated 25th November, 1955.]

URANIUM AS A FUEL

AT Calder Hall nuclear generating station, which is described in this issue, natural uranium is used as fuel in the reactors. Since the same material is to be employed in the initial stations to be constructed by the Central Electricity Authority it may be of interest to examine the value of natural uranium as a fuel, drawing a few comparisons with coal.

Natural uranium consists substantially of one part by weight of U235 and 140 parts by weight of U238. In nuclear reactions involving natural uranium and slow neutrons the U235 atoms are the ones that are usually split. When a U235 atom is split after absorbing a neutron the nuclear equation will be something like the following with its mass equation:—

$$\begin{array}{lllllll} 92U235 & + & 0N1 & \rightarrow 92U236 \rightarrow & 57La148 & + & 85Br85 + 30N1 \\ 235{\cdot}124 & & 1{\cdot}009 & & 147{\cdot}961 & & 84{\cdot}938 \quad 3{\cdot}027 \end{array}$$

The mass sum of the left-hand side is 236·133, and that of the right-hand side 235·926, which shows a difference in mass of 0·207 units. This "boils off" as energy equivalent to $0{\cdot}207 \times 931 = 193$ MeV or approximately 200 MeV.

Since 1 MeV $= 1{\cdot}60 \times 10^{-6}$ erg it follows that 200 MeV, the energy from one split U235 atom, is 320×10^{-6} erg or $3{\cdot}20 \times 10^{-11}$ watt-sec. In other words, $3{\cdot}1 \times 10^{10}$ fissions/sec are required to produce 1 watt.

Now in 1 lb of U235 there are $11{\cdot}62 \times 10^{23}$ atoms and if all of these were fissioned, the energy released would be:—$11{\cdot}62 \times 10^{23} \times 3{\cdot}20 \times 10^{11}$ watt-sec $= 37{\cdot}2 \times 10^{12}$ watt-sec or 10·32 million kWh.

Alternatively, if 1 lb of U235 were fissioned at the rate of $3{\cdot}1 \times 10^{10}$ fissions/sec we would get power at the rate of 1 watt for $1{\cdot}032 \times 10^{10}$ hours. Similarly, $3{\cdot}1 \times 10^{13}$ fissions/sec would give 1 kW for $1{\cdot}032 \times 10^{7}$ hr and $3{\cdot}1 \times 10^{16}$ fissions/sec would give 1 MW for $1{\cdot}032 \times 10^{4}$ hr.

Since 1 kWh is equivalent to 3,413 B.Th.U the energy released by fissioning all the atoms in 1 lb of U235 is $10{\cdot}32 \times 10^{6} \times 3{,}413$ B.Th.U. If the calorific value of coal is 12,000 B.Th.U./lb and if all the atoms in 1 lb of U235 are fissioned, then 1 lb of U235 is equivalent to:—

$$10{\cdot}32 \times 10^{6} \times \frac{3{,}413}{12{,}000} = 3 \times 10^{6} \text{ lb of coal.}$$

In other words, 1 ton of U235 is equivalent to 3,000,000 tons of coal.

There are slightly fewer atoms in 1 lb of natural uranium than there are in 1 lb of U235, but the difference is small

so that if all the atoms in 1 lb of natural uranium could be split then 1 lb of natural uranium would also release as much heat energy as 3,000,000 lb of coal. The complete fissioning of all the atoms in 1 gram of U235 will release:—

$$\frac{3{\cdot}20 \times 10^{-11} \times 6{\cdot}023 \times 10^{23}}{235{\cdot}124} = 8{\cdot}2 \times 10^{10} \text{ watt-sec}$$

$= 2{\cdot}3 \times 10^{4}$ kWh or 1 MW-day (approx.).

This means that 1 gram of U235 fissioned per day gives roughly 1 MW.

The U235 content of 1 metric ton of natural uranium is 7,000 grams. Therefore, if just under half the U235 content of 1 metric ton of natural uranium is fissioned we would get about 3,000 MW-days of energy released. Hence, natural uranium when used in present-day reactors has a heat energy of 3,000 MW-days/ton or one ton of the material is equivalent to 10,000 tons of coal. The reason why only such a low conversion factor can be realised at present is because the atomic ash, the fission product, accumulates in the fuel rods and eventually stops the reaction.

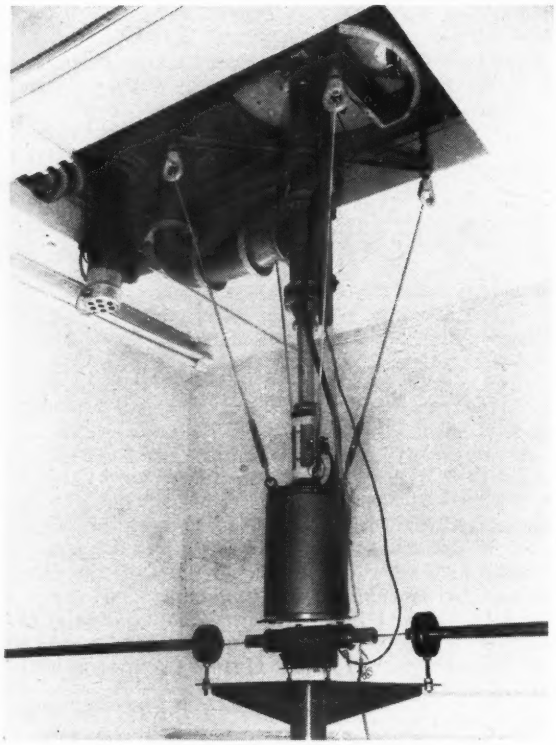
When natural uranium is used in a Calder Hall type reactor, some of the neutrons (one in every fission) released in the fission reaction are used to carry on the chain reaction. The others either escape or are absorbed by the unsplittable atoms, the U238, and convert it eventually into plutonium, a new element that is also splittable. If the spent fuel rods are processed and the fission products and the plutonium formed are separated, the plutonium being again used in the same reactor, it is estimated that over one per cent of the natural uranium can be burnt. In this case 1 lb of natural uranium will be equivalent to 30,000 lb of coal.

To approach the theoretically complete burn-up of all the atoms in 1 lb of uranium, i.e. to reach the equivalent of 3,000,000 lb coal or one million MW-days/ton, use will have to be made of breeder reactors in which more fuel is produced from fertile material than is burnt.

To illustrate this, suppose that 1,000 lb of natural uranium was taken and separated into its two component kinds of atom, we would then have 7 lb of U235 and 993 lb of U238. If the nuclear fire were started in the 7 lb of U235, for every U235 atom that split on average $2\frac{1}{2}$ new neutrons would be produced. One of these would be required for carrying on the reaction and $1\frac{1}{2}$ would be spare. If the 993 lb of U238 were stacked round the nuclear fire of U235 the $1\frac{1}{2}$ spare neutrons from the fission could be absorbed in the U238 blanket where they would produce $1\frac{1}{2}$ atoms of plutonium for every 1 atom of U235 that split.

When all the 7 lb of U235 had been consumed there would remain a mass of $982\frac{1}{2}$ lb of U238 containing $10\frac{1}{2}$ lb of plutonium. After separating the plutonium from the U238 we could then start a new fire with the $10\frac{1}{2}$ lb of plutonium, stack round it the $982\frac{1}{2}$ lb and produce a further 16 lb of plutonium. We could continue in this way until all the original 1,000 lb of natural uranium had been split up to give the equivalent of 3,000,000 lb of coal for each pound of uranium. Because of losses in processing and other causes, it is not likely that all the uranium would be burnt, but figures of 1 lb of uranium equivalent to 30,000 or 60,000 lb of coal should be readily attainable in the near future. A figure of 1 lb of uranium equivalent to 1,000,000 lb of coal should be reached in the future.

Irradiation Laboratory



View of cable passing through the electron beam in the B.I.C.C. irradiation laboratory

TO investigate the special properties of irradiated dielectric materials, the research organisation of British Insulated Callender's Cables, Ltd., have for several months been operating a two-million-volt Van de Graaff accelerator at their Wood Lane laboratories. This equipment was specially chosen for its flexibility in that it can act variously as a source of electrons, positive ions, gamma rays and neutrons.

In particular, the high energy radiation thus produced is being used to modify the structure and properties of conventional polythenes. An exhaustive programme of study of the physical and electrical properties of such materials after irradiation, has been started, with special emphasis on their uses as cable insulants.

The irradiation laboratory comprises a central generator block of two storeys, with the target room on the ground floor immediately under the generator room, flanked on each side by cable handling and control laboratories. The concrete walls of the target room are 3ft thick to prevent the radiation in the laboratories from rising above the tolerance level, while those of the generator room in which the radiation intensity is lower, are 2ft thick. Cable under radiation traverses the target room through two slits in the concrete walls, and is handled by conventional take-up and haul-off machinery.

The leakage of dangerous amounts of X-radiation and of electrons into the laboratories is prevented by covering the slits on the outside with 6in of lead bricks and on the inside with rubber snuggers and aluminium doors. The electron beam from the accelerator tube in the generator is scanned electro-magnetically so that it emerges from the aluminium window of the scanning bucket as a beam having its longer axis parallel to that of the cable.

With these arrangements it has been found possible to process continuously polythene insulated cables. First investigations into the properties of such cables, after irradiation, have indicated that amongst other advantages, a substantially raised softening temperature results. The plant will greatly assist in the assessment of irradiated materials for general use in the cable industry.

Economic Integration of Western Europe

Effect on the British Electrical Industry

BY A CORRESPONDENT

THAT the Federation of British Industries have found it necessary to ask for more time to consider the advice it will give the Government about joining the proposed European free trade area comes as no surprise to those who have studied the question in all its many-sided aspects.

From the spate of newspaper articles and Press comment which have appeared during the last week or two the main proposals will be fairly well known to readers of the *Electrical Review*. The six nations comprising the European Coal and Steel Community—Belgium, France, Holland, Western Germany, Italy and Luxembourg—propose to form a customs union and common market. These six countries already have a common market for coal and steel and its success, coming after gloomy prophecies of failure, has encouraged the six to extend the common market from coal and steel to all goods, with the probable exception of agricultural products. In other words an internal free-trade area would be created by the dismantling of national tariffs, and quota restrictions, among the six participating countries and the erection of a single common tariff against non-participants. A common or uniform tariff against "outsiders" is an obvious pre-requisite to the establishment of an internally free-trade zone.

A draft treaty has already been drawn up following a meeting of the "six" at Messina last year. Among the main points of agreement is that during a transitional period of twelve years (if subsequently found to be necessary the period may be extended to fifteen years) internal customs duty would be progressively abolished in stages of 10 per cent in the first year, 30 per cent in the first four years, 60 per cent during the first eight years and finally removed altogether at the end of the transitional period.

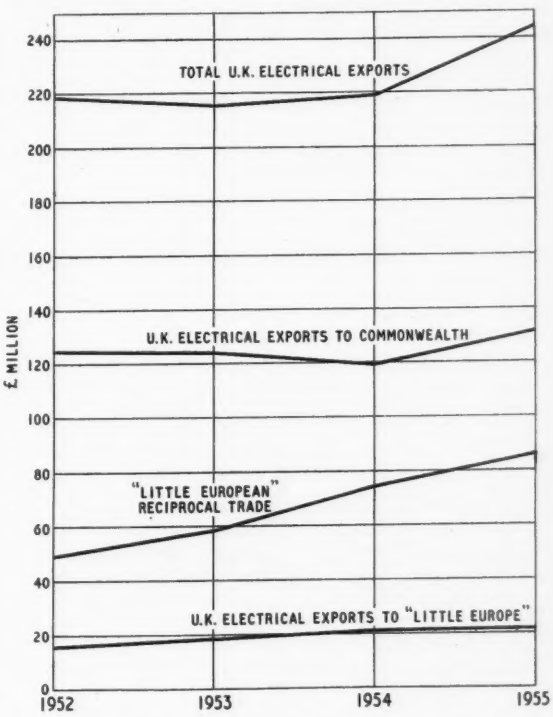
But the plan for "Little Europe" goes even further. Free movement of capital and labour, the harmonisation of fiscal systems and co-ordination of social services are also envisaged, as well as, *inter alia*, the joint development of transport, the creation of a joint organisation for the peaceful development of atomic energy (the Euratom project) and last but not least, the co-ordination of national power development policies and the development of exchanges of electricity, and, be it added, of gas.

These brief details give a clear indication that the plan represents a much closer association than is generally understood by a customs union. If indeed they really mean what is stated, the free movement of capital clearly implies that rates of interest in the participating countries would have to be brought into line and that one participating country could not indulge in a spending spree while its neighbour imposed a severe credit squeeze.

The free movement of labour and the co-ordination of social services imply that wage rates and working hours would have to be uniform throughout the Community; also that unemployment and sickness benefits, and other social amenities would all have to be brought into line. The harmonisation of fiscal systems also suggests that some uniformity in taxation at various levels would have to be achieved.

The combined population of the proposed new Community is in the region of 160 million, that is, roughly equivalent to that of the United States. It is generally thought that if the proposals of the "six" seem likely to be implemented other countries will probably wish to join in, either as full members of the Community or as associate members; those countries are Austria and Switzerland and the Scandinavian countries. The total population of such a bloc would be about 200 million. The foregoing information about the proposed Community area may appear to be unnecessarily detailed but as complete a picture as possible must be built up in the mind's eye to enable the possible repercussions on the United Kingdom to be gauged should the European project be implemented.

Electrical manufacture on the Continent has been growing steadily since the war and reciprocal trade among the "six" has expanded in proportion, as the accompanying diagram shows. Since 1952 reciprocal trade in the electrical field has almost doubled. In that year the equivalent of £48·5 million worth of electrical trade was done among the six; by 1955 the total had risen to £86·6 million. During this period United Kingdom electrical exports to the "six" also rose from £16·1 million in 1952 to £22·5 million in 1955. So far as imports are concerned (not shown in the graph) the figures were £4·8 million and £11·9 million respectively, from which will be seen that the United Kingdom maintains a favourable balance with the proposed Community. The Organisation for European Economic Co-operation has set up a working party, on which the United Kingdom is represented, to examine ways and means of associating other members of O.E.E.C. with



U.K. electrical exports and European reciprocal trade

the projected free-trade area. At present H.M. Government are awaiting the views of British industry towards the various courses of action that may be open to this country. In barest outline three principal courses are possible, namely:—

(*a*) Full membership, which implies active participation in the various measures proposed by the "six."

(*b*) Associate membership and the adaptation of the United Kingdom's tariff to enable direct co-operation with the Community to be maintained.

(*c*) Abstention from all direct association with the Community.

Dealing with the latter possibility first, obviously if the United Kingdom were to cold-shoulder the proposals a market roughly the size of the U.S.A. would be enclosed within a high tariff wall which British manufacturers might, or might not, be able to scale. Meanwhile, our main competitor, Germany, would be able to export freely to any member of the Community area. Furthermore, if the United Kingdom were to hold herself completely aloof she would have no say in the safeguarding of her own special interests and our Continental competitors, having the advantage of a large home market in Western Europe, would be enabled to compete with us more effectively in third markets, such as Latin America, the Far East and elsewhere.

Full membership would mean that we should lose control of our own tariff against third countries—including members of the Commonwealth—after the creation of a single common tariff, and would probably spell the end of Imperial Preference. Other objections are that complete integration of our economic and social legislation with that of the European Community would not be acceptable to the British public politically and constitutionally.

There then remains the third alternative, namely, that of associate membership. By such an association we could control our own tariff *vis-a-vis* third countries and continue to allow imports from the Commonwealth into the United Kingdom at preferential rates, and *vice versa*. Our association with the Community could extend to granting free entry of their goods into the United Kingdom, or at specially favourable rates, in return for reciprocal treatment in respect of British goods entering the Community area.

Effect of Proposals

At this stage it is only possible to guess what effect on the British economy any of the courses open to us would have. Each one of the proposed measures to be undertaken by the "six" needs detailed study, firstly from the aspect of how they are expected to operate on the other side and then from the angle at which such measures are to be approached from the British side. In addition to all this, it is necessary to ask such questions as: Will the United Kingdom keep separate trading accounts with each individual partner of the Community?; will they for their part adopt a common currency for external purposes?; will the £ sterling be made freely convertible? and so on.

Advocates of the scheme declare that vast new markets would be opened up for British exports, but against that it is said that the British home market would be "flooded with cheap imports." Continental competition in the home market, it is said, would stimulate British industry to improve its efficiency. No doubt the really efficient firms would tend to become more efficient and able to withstand competition, but doubtless a certain amount of readjustment would be necessary and several firms would probably not survive.

The claim is made that the accumulation of new capital would be stimulated to the advantage of the Commonwealth. Provided the scheme fulfils its main objective, that of promoting the growth of economic activity in Europe, this may well prove to be the case. British participation in the scheme, it is said, would enable the European economy to compete more effectively with the American and Soviet blocs but on the other hand such participation may weaken our bonds with the Commonwealth countries.

When all is said and done the proposed scheme is not likely to be carried out immediately. Indeed, it may never materialise. If and when it is put into effect, however, it will take more than a decade to reach its final shape and during that period the British electrical industry, along with other industries, will have plenty of time to make whatever adjustments may be necessary.

Gas Council's Report

A NET surplus of £531,628 on a gross income of £346 million is shown in the report of the Gas Council for the year ended 31st March last (H.M. Stationery Office, 7s). Eight of the twelve Gas Boards showed surpluses and the other four deficits.

The number of gas consumers rose by 127,195 to 12·8 million of whom about 12 million were domestic users. Sales of gas increased from 2,636 million therms to 2,649 million. Domestic consumers took 1,350 million therms (against 1,379 million in 1954-55), a decrease of about 2 per cent, and industrial consumers 751 million (against 720 million), about 4 per cent more. The average revenue per therm rose from 16·4d to 17·7d.

Mention is made in the report of the adverse effect upon the sale of domestic appliances of hire-purchase restrictions and higher purchase tax. The result is said to have been declines of 37·6 per cent in the case of hire-purchase and of 3 per cent in cash and credit sales. The sale and hire-purchase of appliances resulted in a net charge of £105,687 on the accounts of the industry as a whole; in the preceding year there was a net income of £1,366,254.

A table shows the following sales of appliances for cash or on hire-purchase:—

Type of Appliance	Numbers sold (thousands)	
	1954-55	1955-56
Cookers	818·1	584·8
Space Heaters (gas)	166·2	159·1
Water Heaters	290·7	177·2
Wash Boilers	242·0	190·3
Washing Machines	47·4	35·2
Refrigerators	21·1	22·0

Thus, in the case of cookers, the mainstay of the industry's sales of appliances, the numbers dropped substantially—by 28·5 per cent. There were increases in the cash sales of gas space heaters, water heaters, washing machines and refrigerators.

Radio Engineers

The 30th annual report of the Council of the British Institution of Radio Engineers for the 12 months ended 31st March, 1956, records a net gain in membership of 310. The number of proposals for election, transfer or reinstatement to the various grades (1,066) was the highest yet received, but there has been a decrease in respect of the student grade. Reference is made to the Grant of Arms made to the Institute last February. The election is reported of the fifteenth honorary member in the person of Professor G. W. O. Howe "in recognition of his contributions to the advancement of radio science and in particular for his long series of notable editorial articles in the *Wireless World*."

VIEWS on the NEWS

By REFLECTOR

A LETTER from Lord Gridley protesting against the Government's curtailment of the electricity supply authorities' programme by means of the capital "squeeze" appeared in *The Times* last week. While there was nothing new in the letter it is as well that authoritative voices should be raised from time to time against this damaging policy. Lord Gridley spoke as one with intimate knowledge of power supply and experience of the "loss, inconvenience and hardship" (to which he referred in his letter) caused by earlier running down of the electricity supply system. Both generation and distribution were dealt with. I think that possibly it is the latter which calls more urgently for attention. It is not only that extensions are being held up, existing distribution systems are badly in need of improvement and reinforcement. If, as has been said, rural electrification is not to be seriously interfered with (and it should not be) urban systems must suffer even more. Lord Gridley rightly pointed to electrification as one potent means of clearing the air (he also gave gas a look in) and he again stressed the fact that the electric power station was the only satisfactory means of dealing with the increasing quantities of small coal and duff which result from modern machine mining.

* * *

Office staffs of industrial concerns are perhaps so engrossed in their paper work that they have little time to discover what it is they are really dealing with. It is a good thing, therefore, if it can be arranged for the clerical people to be shown around the works to give them a better idea of their firm's products, as Henley's appear to be doing. The need for instruction was shown by what, I hope, was a true story told by Mr. S. J. Beaney at last week's staff dinner. A lady member of the staff touring one of the company's works was particularly fascinated by the wire tinning process. Her guide wondered why this comparatively uninteresting operation should be of so much interest to her. She confessed that up to that moment whenever she had to type the phrase "tinned copper wire" she envisaged wire in cans—something like sausages.

* * *

At the same dinner the chairman, Sir John Dalton, referring to the Henley collection at the Woolwich Works, caused some merriment by saying that "Mr. Savage's museum of Henley relics was really worth seeing."

* * *

Falls in temperature during the summer months do not worry the Central Electricity Authority much; indeed they may help to improve load factor. In the United States cooler summer weather may possibly be welcomed by some electricity supply companies (or utilities) as a means of relieving their peak loads. A survey of ninety of these companies made by the *Electrical World* (New York) showed that fourteen experienced their highest demand during the summer and the number is said to be growing. The reason is, of course, the heavy air-conditioning load which they carry. America, similarly to this country, had a cooler summer than usual this year and in consequence the demand failed to reach the estimated figures, although it was still higher than last year. Actually, the American utilities are not generally worried by peak demands for they seem to have adequate spare capacity to meet them.

* * *

The Eastern Electricity Board has appealed to householders to assist meter readers when they call by making access to the electricity meters easier. The Board particularly has in mind meters placed in cupboards which one of its officials says are frequently stuffed with "everything but the kitchen sink." Whilst there is a tendency to put unwanted household objects out of sight in the cupboard, many householders will no doubt feel that the difficulty would not have arisen if the meters had been placed in an accessible position. In my own house, if I have to replace a fuse or try to read my meter, I have to do so on hands and knees in a confined space.

* * *

It is reported in *Public Service* (the journal of the National and Local Government Officers' Association) that the Central Electricity Authority is considering the reintroduction of a scheme adopted in 1951 whereby it and the Electricity Boards will make up the pay of called-up reservists to the level of their civilian earnings. There is, however, a "home saving factor" deduction amounting to £1 a week for unmarried employees and 10s for married men or single men with dependent relatives. Similar arrangements made by the gas industry are set out on the same page of the journal but I notice that in this case the deductions amount to £1 10s and £1 a week respectively. The presumption is that it costs a gas man more to live at home than it does an electrical man; I can think of no other reason for the difference.

* * *

Here is a good example of contemporary advertising which appeared in the *Electrical Review* of 15th October, 1876:—

> "*Electric Bells for Domestic Use.*—It is now conceded that the ringing of house-bells by means of cranks and wires is a clumsy and bygone contrivance, and altogether a thing of the past—as primitive and as rude, when compared with the electric system, as the drawing of water from a well for house-supply by rope and bucket, instead of by a pump or other hydraulic machine. In the electric system, all pulling and tugging, and consequent breaking of wires, is done away with; for, however distant the bell may be, and however tortuous its course, it may be rung by means of the slightest pressure of the finger on a little ivory button. To secure this desirable result, and to be lasting, three things are necessary—the exclusive use of first-class and highly-finished materials; skilled workmen to perform the mechanical part; and an instructed mind, combined with long practical experience, to direct their operations. . . ."

PERSONAL AND SOCIAL

News of Men and Women of the Industry

At a Council meeting held at the recent conference at Scarborough of the Purchasing Officers' Association, **Mr. R. J. Mitchell** was elected president of the Association for 1956-57. Mr. Mitchell has been the purchasing manager of the Morgan Crucible Co., Ltd., since 1945. He first entered purchasing nearly thirty years ago, when he joined the British Electrical Transformer Co., Ltd. This company later became a subsidiary of Crompton Parkinson, Ltd., and in 1936 Mr. Mitchell was appointed to establish and manage the purchasing department of the Atlas Sprinkler Co., Ltd., six years later taking up a similar position with the Young Accumulator Co., Ltd., another Crompton Parkinson subsidiary.

Mr. James F. Galloway, M.B.E., area engineer for Edinburgh for the South of Scotland Electricity Board, retired on 30th September. Mr. Galloway served his apprenticeship with Bruce Peebles & Co., Ltd., and after attending the Heriot-Watt College joined the mains staff of Edinburgh Corporation Electricity Department in 1912. During the 1914-18 war he held the rank of captain in the Royal Engineers, and in the last war was a lieutenant, under Mr. J. Eccles, in the 4th Battalion, Edinburgh Home Guard, in "P" Company, which was attached to Portobello power station. His service of forty-four years with Edinburgh Corporation, the South East Scotland Electricity Board and South of Scotland Electricity Board resulted in a wide experience in electrical matters. For his services to the industry he was awarded the M.B.E. in 1952.

Mr. J. F. Galloway

The Ministry of Supply announces that **Mr. T. D. Jacobs** has been appointed Director of Instrument Production.

Messrs. F. H. Colley, C. Ellis and **D. O'B. Minogue,** who for the past three and a half years have been special directors of Edward Pryor & Son, Ltd., Sheffield, have been appointed full directors as from 1st October.

The parent company of the 600 Group recently announced that it had changed its name to the George Cohen 600 Group, Ltd., and transferred its trading activities to a new wholly-owned subsidiary called George Cohen Sons & Co., Ltd. In addition to those who are already on the board of the holding company, the following, all of whom have held high executive positions with the company for many years, have been appointed directors of the new subsidiary company:—**Messrs. J. A. J. Blanckensee, D. W. Cooper, A. S. Gill, C. E. G. Nye, J. H. Pawley** and **Miss E. P. Wood.**

Mr. J. A. Dewhirst and **Mr. P. H. Ogden** have been appointed local directors of George Cohen Sons & Co., Ltd. They will continue to operate from their headquarters at the company's works at Leeds and Sheffield respectively.

Following on the appointment, reported in our last issue, of Mr. W. J. A. Sykes as chief mechanical and electrical engineer in charge of the carriage, wagon, mechanical and electrical department of the Southern Region, British Transport Commission, the Southern Area Board has now made the following appointments of senior officers to assist Mr. Sykes:—**Mr. M. G. Burrows** as mechanical engineer; **Mr. F. J. Pepper** as carriage and wagon engineer; and **Mr. H. S. Smyth** as electrical engineer.

The annual dinner and ball of the **Electrical Trades' Commercial Travellers' Association** was held on 5th October at Park Lane Hotel, London, W.1, and the increasing popularity of this event was shown by a record attendance of 375. Among those who attended were Mr. R. Brandon (president) and Mrs. Brandon, Mr. W. Candelatt (chairman) and Mrs. Candelatt, Mr. V. Creer (president-elect) and Mrs. Creer, and Mr. F. J. Simons (vice-chairman) and Mrs. Simons. Branch chairmen were also present.

The South Wales Branch of the Association held its first dinner-dance on 21st September at the Royal Hotel, Cardiff. In addition to the president, chairman and vice-chairman of the Association, many well-known men in the electrical industry attended, including Mr. L. Howells (chairman, South Wales Electricity Board), who was accompanied by Mrs. Howells.

Messrs. V. Creer (president-elect), Mr. R. Brandon (president), Mr. W. Candelatt (chairman) and Mr. F. J. Simons (vice-chairman) with their wives at the annual dinner and ball of the Electrical Trades' Commercial Travellers' Association held in London

The annual general meeting of the North Western Branch of the Association will be held on 12th November (7 p.m.) at the "Waggon and Horses," Southgate, Deansgate, Manchester. If time permits a visit will be made to British Railways Signalling School.

Mr. W. E. Swale, who deals in this issue with the influence of the textile industry on public electricity supply, studied in Germany and worked with Brown-Boveri & Co., Mannheim. After ten years as sales representative with the Metropolitan - Vickers Electrical Co., Ltd., he joined Manchester Corporation Electricity Department in 1929 as the first municipal power sales engineer in the country. Since retiring Mr. Swale has been busy with consulting work and technical writing, and his book on "Electricity in the Textile Industries" has recently been published.

Mr. W. E. Swale

A record company of 749 attended the annual staff dinner and dance of the **Henley Companies** at the Dorchester, London, W.1, last Saturday. Sir John Dalton, the chairman of the group, presided and responded to the toast of "The Henley Companies" proposed by Mr. J. H. Savage, manager of the Woolwich Works. Mr. Savage, in his speech, gave some interesting information about William Thomas Henley who founded the

company bearing his name over a century ago and handed to Sir John Dalton a coach lantern used by Henley, the key of the first factory and a minute book. In the course of his reply Sir John said that the last annual dinner had been followed by the best year in the companies' history. He referred to the presence at the dinner of Mr. Wood, general manager of South African Cables, Ltd., and Mrs. Wood, and said that he was leaving for a visit to South Africa on the following Thursday (yesterday). The toast of "The Ladies" was proposed very wittily by Mr. S. J. Beaney (director and secretary) and ably replied to by Miss N. Young (head office).

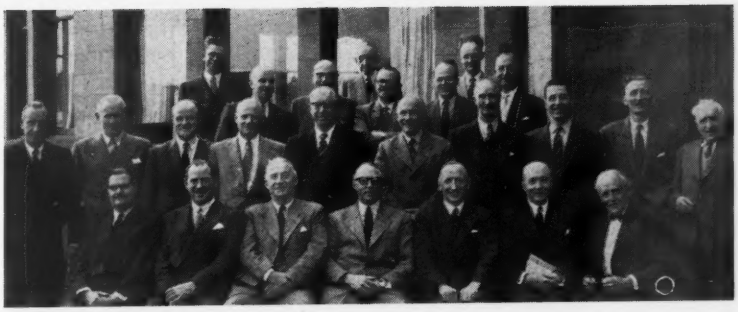
Mr. L. W. Barclay, B.Sc., research engineer with E. K. Cole, Ltd., has been selected as a member of the ionospheric research team on the Royal Society's Antarctic Expedition, which is being organised in connection with the forthcoming International Geophysical Year. Mr. Barclay left E. K. Cole, Ltd., on 12th October and, after training at the Radio Research Station, at Slough, sails with the expedition on 14th November. He will return home in April, 1959. He joined E. K. Cole, Ltd., in 1950 as a radio engineering apprentice.

Mr. Alan Robertson has been appointed branch manager for Scotland for the Jackson Electric Stove Co., Ltd., in succession to the late Mr. Hector Mackenzie. Mr. Robertson was educated at Renfrew High School, and served an apprenticeship as an electrical engineer with the India Tyre & Rubber Co., Inchinman, remaining with them as electrical engineer until he joined the Jackson Electric Stove Co., under Mr. Mackenzie, in April, 1951.

Mr. A. Robertson

In accordance with its usual custom the Scottish Section of the **Electrical Wholesalers' Federation** invited the Council to hold one of its meetings in Scotland, and this annual function was held at Gleneagles in the week commencing 1st October. Apart from the Council, the Scottish members invited the Councils of the Electric Lamp Manufacturers' Association and the Rubber and Thermoplastic Cable Manufacturers' Association and a number of representatives of kindred associations. The E.W.F. Council meeting was held on 3rd October and a representative number of Scottish members attended part of the meeting and joined in the discussion.

A golf competition was held on 4th October, the cup winner being Mr. C. Scott, who also received the president's prize of a brandy flask. The second prize, which was also a brandy flask presented by the president, was won by Mr. H. Parrott. Mr. J. Aikman, jun., secured a booby prize. Mrs. W. E. Hind received the first prize in the ladies' section and Mrs. W. H. McIntosh the second. At the dinner in the evening, Mr. E. H. Stein, chairman of the Scottish Section, presided and proposed the health of the guests, to which Mr. A. E. Page responded. The toast of "The Ladies" was proposed by Mr. T. D. Woods, president of the E.W.F., and Mrs. F. E. C. Miller responded. The toast to the chairman was proposed by Mr. W. Lewis Smith and the chairman, Mr. Stein, replied. The evening concluded with dancing.



The E.W.F. Council with Scottish members at Gleneagles. Seated (left to right): Messrs. F. J. Blackwell, T. S. Weston, C. H. Blackburn (vice-president), T. D. Woods (president), E. H. Stein (chairman, Scottish Section), A. Baillie (hon. sec., Scottish Section) and A. B. Wildsmith (director). Second row: Messrs. G. W. Cartwright, W. H. McIntosh, F. Dunnet, C. H. Marr, H. Riley, J. W. E. Rutherford, J. M. Milne, J. E. McIver, G. H. Kenwright and L. Scop. Third row: Messrs. P. B. Etheridge (deputy director), R. E. Silvey, J. Aikman, sen., W. C. Yuille, G. E. Christie, J. Aikman, jun., T. T. Young and G. Conradi

Mr. C. A. French, A.S.A.A., A.I.M.T.A., assistant chief accountant at the Central Electricity Authority's headquarers, has been appointed a deputy chief accountant at headquarters. Mr. French served first as an accounting pupil with the British American Tobacco Co., Ltd., and subsequently worked in the finance departments of the Reading, Barking, Southampton and Stockport Borough Councils, becoming deputy borough treasurer of the Smethwick Borough Council in 1942. He joined the British Electricity Authority at headquarters in 1948, and was appointed assistant chief accountant in 1949.

Sir Nutcombe Hume, K.B.E., M.C., has been appointed chairman of Edmundsons Electric Co., Ltd., in succession to the late Brigadier-General Wade H. Hayes, O.B.E. Sir Nutcombe Hume has been a member of the board since the formation of the company in 1948.

General Sir William D. Morgan, chairman of Siemens Brothers & Co., Ltd., has been appointed chairman of Submarine Cables, Ltd., for three years commencing 1st October. **Mr. J. N. Dean,** the retiring chairman, retains the office of managing director which he holds jointly with Mr. F. S. H. Lemon. Submarine Cables, Ltd., is owned jointly by Siemens Brothers and the Telegraph Construction & Maintenance Co., Ltd., and its chairman is nominated by these two companies in rotation.

Mr. G. L. Copping, M.I.H.V.E., A.M.I.Mech.E., who has served with the Blackman Export Co., Ltd., for the past fifty-three years, relinquished his directorship on 25th September, upon the acquisition by Keith Blackman, Ltd., of the majority shareholding and control of the company. He will in future serve in a consultative capacity with Keith Blackman, Ltd.

Mr. Ernest W. Betts, sales executive of Bromley-Langton Electric Wire & Insulator Co., Ltd., Slough, was recently presented with a canteen of cutlery to commemorate twenty-five years' association with the company. Mr. Betts is also a director of two associated manufacturing concerns of Bromley-Langton.

Mr. R. Lessing, Ph.D., F.R.I.C., F.Inst.F., M.I.Chem.E., who has been actively associated with the National Smoke Abatement Society and its parent body, the former Coal Smoke Abatement Society, since 1908, has been elected as president of the National Smoke Abatement Society in succession to **Sir Ernest Smith,** C.B.E., D.Sc., F.R.I.C. Sir Ernest has been re-elected as hon. treasurer. At the annual general meeting of the Society on 5th October it was resolved to hold a special general meeting at an early date to consider proposals for the incorporation of the Society and changing its name to National Clean Air Society.

This year is the centenary of the Corps of Royal Engineers and as a centenary celebration the London Group of the **Royal Engineers' Association** is organising its fourth London sapper reunion on 24th November (7 p.m.) at the Duke of York's Headquarters, Chelsea. The R.E. band from Chatham will be in attendance and Leslie Sarony will be the M.C. Tickets (3s 6d each) are obtainable

Calder Hall Power Station (see pages 691–702). Left to right: Mr. R. V. Moore (chief design engineer), Mr. A. Young (resident engineer for construction), Mr. K. L. Stretch (works manager), and Mr. H. G. Davey (works general manager)

from Mr. J. S. Pearson, hon. sec., London Group, Room 31, Horse Guards, Whitehall, S.W.1.

Mr. F. E. Pile has been appointed district chief clerk of District 347 (Cardiff East) in the Central Sub-Area of the South Wales Electricity Board. He replaces **Mr. G. D. Cooksley** who has taken up an appointment with the Merseyside and North Wales Electricity Board.

The **Electrical Industries Benevolent Association** tells us that all tickets for the annual ball to be held on Friday, 9th November, at Grosvenor House, London, W., have now been sold. There has been an even greater demand this year and although the Association would like to accommodate all applicants, in order that there may be reasonable comfort for all to dance the tickets have had to be limited.

OBITUARY

Mr. G. R. Laithwaite, manager of the Worksop District of the East Midlands Electricity Board, died on 10th October at the age of fifty-seven. Mr. Laithwaite received his early training with the Wigan Iron & Coal Co., Ltd., and joined the Worksop Corporation Electricity Department as mains engineer in 1931, becoming engineer and manager in 1939. In 1948 he was appointed manager of the Worksop District which in 1951 was enlarged to include the area formerly supplied by the East Retford Corporation Electricity Department.

Mr. G. W. Spencer Hawes.—The death occurred on 13th October, at the age of eighty-five, of Mr. George William Spencer Hawes, O.B.E., M.I.E.E., who was chairman of the Electric Construction Co., Ltd., from 1942 until his retirement for health reasons in 1948. He had been a director of the company since 1930.

Mr. T. L. O. Dixon.—The death is announced of Mr. T. L. O. Dixon, sales director of Musgrave & Co., Ltd., Belfast. He was forty-nine years of age and had been associated with the company for over thirty-two years.

Mr. H. C. Wells.—The death occurred recently of Mr. Harold Charles Wells, M.I.E.E., who retired in 1953 from the position of engineering adviser to the chief engineer of the London Electricity Board. Before nationalisation Mr. Wells was associated with the County of London Electric Supply Co. for forty years and was for many years chief mains engineer.

Mr. B. H. Musgrave.—A memorial service for Mr. Brian Herbert Musgrave was held on 10th October at St. Michael's, Cornhill. The Rev. La Porte-Payne officiated and gave an address. The chairman of the Telegraph Construction and Maintenance Co., Ltd., Mr. J. N. Dean, and the chairman of Submarine Cables, Ltd., General Sir William D. Morgan, G.C.B., D.S.O., M.C., and their co-directors and members of the staff, as well as many friends and associates, attended the service. Relatives present were Mr. Iain and Mr. Fraser Musgrave (sons), Sir Cyril and Lady Musgrave, and Mr. and Mrs. Geoffrey Musgrave (cousins).

Hydro-Electric Engineers' Russian Visit

A delegation of six British experts in hydro-electric engineering left London by air for Moscow on 10th October for a two weeks' visit to Russia to study hydro-electric projects. The visit has been arranged by the Institutions of Civil, Mechanical and Electrical Engineers and the Soviet Relations Committee of the British Council at the invitation of the Soviet authorities.

The group is led by Sir John Hacking, M.I.E.E., consultant to Merz & McLellan, consulting engineers. Other members are Mr. A. A. Fulton, F.R.S.E., B.Sc., M.I.C.E., member of the Council of the Institution of Civil Engineers, general manager of the North of Scotland Hydro-Electric Board, Edinburgh; Mr. S. P. Hutton, Ph.D., M.Eng., A.M.I.C.E., A.M.I.Mech.E., head of the Fluid Mechanics Division, D.S.I.R., Mechanical Engineering Research Laboratory, E. Kilbride, Glasgow; Dr. W. MacGregor, D.Sc., A.M.I.C.E., director of George Wimpey & Co.; Mr. R. W. Mountain, B.Sc., M.I.C.E., M.I.E.E., partner in Kennedy & Donkin, consulting engineers; and Mr. H. West, M.I.E.E., a director and chief electrical engineer of the Metropolitan-Vickers Electrical Co., Ltd.

It is expected that the delegation will visit hydro-electric power stations at Dniepr, Kakhovka, Stalingrad, Sevansky Kaskad and Khramsky. Other items in the programme will probably be visits to research institutes concerned with hydro-electric power in Moscow, Stalingrad and Erevan and a factory in Leningrad producing water-turbines. The group returns to London on 24th October.

A return visit by a group of Soviet engineers to the United Kingdom will probably take place early next summer.

EXPORT GUIDE

At a Press conference in London this week Mr. Leslie Gamage, vice-chairman and joint managing director of the General Electric Co., Ltd., and president of the Institute of Export, announced the production of a new publication dedicated to the export trade of this country, the G.E.C. Export Guide. Issued by the Economic and Marketing Research Unit of the company, it offers information about the export prospects of thirty-six groups of manufactured products in Britain's thirty-four major overseas markets. Only countries with a British export bill of over £20 million in 1955 have been included.

The information is obtained from a variety of sources, including the trade and navigation accounts of the Board of Trade and the trading returns of foreign countries, and is up to date at the time of going to press. Diagrams depict the broad general outlook for British exports in world markets and the trends of British exports for the selected product groups. A special feature of the guide is a report on British exports which gives background information relating to world trade in general, and Britain's position in particular.

Copies of the guide, which will be published quarterly and circulated free of cost, are to be sent to 10,000 manufacturers and export traders.

INDUSTRIAL NEWS

Engineering Industries Association

The London regional organisation of the Engineering Industries Association held its 9th annual exhibition last week at the new hall of the Royal Horticultural Society, London. The exhibits of the 150 or so firms represented covered a very wide field and included a number of items of interest to electrical engineers. The possibilities of printed circuitry were demonstrated by Printed Circuits, Ltd., who produce "Plasmet" continuous copper etched wiring circuits. The Mond Nickel stand was this year combined with that of their associates, Henry Wiggin & Co., Ltd., who were taking part in the display for the first time. The display was devoted to welding, the main feature being a range of welded joints, illustrating the various methods of joining nickel-containing materials.

Among the newly developed items shown by W. H. Sanders (Electronics), Ltd., was a selection of micro-wave instruments and components for operation in the J band (12·4 to 18 kMc/s). Automatic coil winding machines were shown by Frank Whitelegg, Ltd., while gravity die and sand castings of all types were exhibited by the Bucks Die Casting Co., Ltd.

Portable indicating and recording instruments for electrical and physical values were shown by Elliott Brothers (London), Ltd., together with a sensitive hermetically sealed moving coil relay for industrial control applications. Among the items shown by the Martindale Electric Co., Ltd., were commstones and grinding tools, undercutters, voltage testers, etchers, sprayers, blowers and a range of protective equipment.

Consulting Engineers and Nuclear Energy

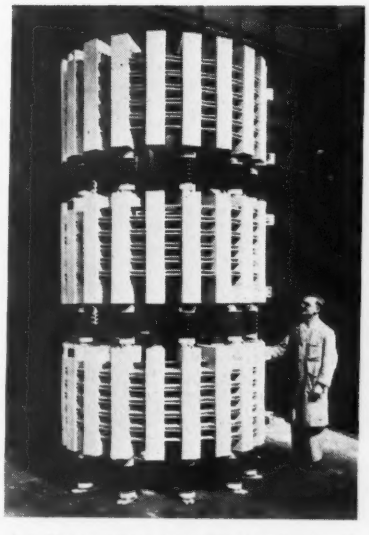
The role of consulting engineers has been appreciated by the Atomic Energy Authority which has granted facilities to members of the Association of Consulting Engineers to obtain training and experience at its various establishments. A number of members of the Association have therefore had staff attached to the Authority's establishments for some years past and are now equipped to undertake their part in the development of nuclear power in this country and overseas. The A.E.A. found that its own resources were being over-strained by the large programme of nuclear plants required and therefore decided to employ a leading firm, whose partners are members of the Association, as consulting engineers for the power plant layout, services and civil engineering, and as construction agents for the Chapelcross project in Dumfriesshire. This is the second of the A.E.A. plutonium and power producing plants and will be twice as large as the initial section of the Calder Hall station.

Another leading firm, whose partners are also members of the Association, have been appointed consulting engineers by the South of Scotland Electricity Board for the design and supervision of construction of a complete nuclear power station to be built on the Ayrshire coast. This plant is being designed for a capacity of about 250,000 kW and will be the third of the stations visualised in the Government White Paper published in February, 1955.

The A.E.A. is also employing consulting engineers on other special services, and certain electricity authorities have expressed their intention of utilising the services of consulting engineers in connection with future nuclear power plants.

Reactors for Holland

The British Thomson-Houston Co., Ltd., has recently shipped to Intechmij, N.V., Holland, nine 6 kV, 5 per cent on 2·6 MVA cast-in-concrete reactor tiers for the Municipal Electricity Board, Haarlem. These reactors are interesting in that they are the first manufactured by the B.T.H. Co. in which the incoming and outgoing connections are supported from the reactor instead of from the walls of the reactor cells. This arrangement is to suit the common Dutch practice of mounting their feeder reactors immediately above or below the associated banks of switchgear. The B.T.H. Co. has also supplied to Intechmij, N.V., a 10·5 kV, 10 per cent on 34·8 MVA cast-in-concrete reactor tier for the Municipal Electricity Board, Amsterdam-North power station. The reactor, shown in the accompanying picture, is the largest 3-phase tier manufactured by the B.T.H. Co., being 6ft in diameter, 12ft high and weighing about 7 tons.



A B.T.H. reactor tier for the Municipal Electricity Board, Amsterdam

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £197 0s 0d
COPPER, H.C. Electro	ton £281 15s 0d
Fire Refined 99·70%	ton £280 0s 0d
Fire Refined 99·50%	ton £279 0s 0d
COPPER Tubes ..	lb 2s 9½d
Sheet	ton £353 10s 0d
H.C. wire and strip ..	ton £317 15s 0d
LEAD, English ..	ton £114 15s 0d
Foreign	ton £113 0s 0d
MERCURY	flask £83 10s 0d
TIN, block (English) ..	ton £794 0s 0d
ZINC, G.O.B. Foreign	ton £95 5s 0d
Electrolytic	ton —
BRASS Tubes (solid drawn)	lb 2s 3½d
Sheet	ton £289 0s 0d
Wire	lb 2s 11½d
PHOSPHOR BRONZE Wire	lb 4s 4½d
PLATINUM	oz £34 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 27⅛d—27¼d

British Railways

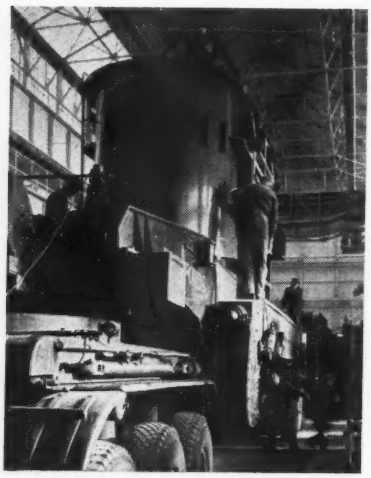
All that the average person wants to know about the operation and upkeep of the British Railways is contained in concise form in a 48-page booklet, "Facts and Figures about British Railways," which has been issued by the British Transport Commission, 222, Marylebone Road, London, N.W.1. Details and statistics of the various services (railway, hotel, ships and ferries) are given. The statistics show that at the end of 1955 there were 2,607 single electrified track miles (including sidings), and the number of electric train miles run (coaching and freight) during the year was 49·9 million, using 909·8 million kWh. Copies of the booklet are obtainable, free, from the B.T.C.

Velindre Steel Works

W. T. Henley's Telegraph Works Co., Ltd., ask us to state that McLellan & Partners were the consulting engineers for the cable contract of the Velindre Works of the Steel Company of Wales, which was featured in their advertisement in our last issue.

Plant for Carmarthen Bay

A 72 MVA 132 kV generator transformer left the works of the Fuller Electrical & Manufacturing Co., Ltd., on 5th October en route to the Carmarthen Bay power station of the



A 72 MVA generator transformer being dispatched from the works of the Fuller Electrical & Manufacturing Co., for Carmarthen Bay power station

Central Electricity Authority, South Wales Division. The accompanying picture shows the unit loaded on the road transporter.

Calder Hall

Four years ago the Shell Petroleum Co., Ltd., were consulted about lubrication by C. A. Parsons & Co., Ltd., in connection with the special plant required for the Calder Hall power station. A programme of experimental work was started at Shell's Thornton Research Centre in Cheshire to evolve these special lubricants and also to study the requirements of future atomic power plant. Many materials have been subjected both to radiation in an atomic reactor and to the cobalt 60 source which has been installed at Thornton, and this work has led to the development of new types of lubricant capable of withstanding very high temperatures and atomic radiation.

We learn that equipment installed by Ekco Electronics, Ltd., at Calder Hall includes reactor period meters and radiation monitors.

Cookery Demonstrations at Birkenhead

Cookery demonstrations were given at the Birkenhead Technical College on 2nd, 3rd and 4th October by Philip Harben. Over 3,000 people attended these shows organised by the Merseyside and North Wales Electricity Board, and saw a variety of interesting applications of cooking by electricity, including six turkeys which were cooked in Jackson electric cookers, and afterwards presented in conjunction with the British Turkey Federation to local charities.

Equipment for Shell Tankers

Siemens Brothers & Co., Ltd., has received orders from Shell Tankers, Ltd., for the installation of radio equipment on the fourteen 18,000-ton tankers which are to be laid down as part of its current programme. The equipment will include not only the compulsory main and emergency transmitters, but also independent short-wave transmitters, auxiliary radiotelephones for direct communication with the shore, rotating frame direction finders, and radar manufactured by the British Thomson-Houston Co., Ltd. These new ships will have a.c. power supply with certain circuits operated on 24 V d.c. For this purpose each ship will have three "Transrecters" made by Siemens Brothers, which will keep the batteries charged automatically ready for use without the need for rotating machinery.

New Cossor Company

Cossor Communications Co., Ltd., has been formed, as a subsidiary of A. C. Cossor, Ltd., to extend the telecommunications interests of the Cossor group. The new company will shortly take over the handling of sales of existing Cossor communications sets, but the main emphasis will be on a completely new range of designs, varying from personal portable sets to a wide variety of heavier equipment. The company's activities will extend not only to radio but to line communications, in close co-operation with the Sterling Cable Co., Ltd., the cable-making subsidiary of the Cossor group. Mr. H. Chisholm, joint managing director of A. C. Cossor, Ltd., is chairman of the new company, with Mr. T. S. Heftman as general manager and technical director. The sales division (Mr. I. Campbell-Bruce is sales director) is at Cossor House, Highbury Grove, London, N.5 (telephone: Canonbury 1234).

330 kV Switchgear for Australia

Following the recent contract for 330 kV air-blast circuit-breakers for the Snowy Mountains Hydro-Electric Authority, the Metropolitan-Vickers Electrical Co., Ltd., has now received (through its associates in Australia, Australian Electrical Industries Pty., Ltd.) an order for similar switchgear for the Electricity Commission of New South Wales. The new order, which is valued at more than £100,000, covers the supply of four three-phase and one single-phase 330 kV air-blast circuit-breakers, type GA11W8, with the associated compressor equipment and seventeen 330 kV multiple-secondary outdoor current - transformers, all of which will be installed at Yass sub-station, a few miles north of Canberra.

Construction of the 330 kV transmission line from the Snowy Mountains power station has begun, initially as two 132 kV circuits which (by rearranging the six conductors) will ultimately form the three twin-phase conductors of the 330 kV circuit, and Yass will be the first link in the Snowy T1/T2-Yass-Dapto-Sydney circuit. It will be a 330/132 kV station with a proposed maximum capacity of 450 MVA feeding the extensive south-western network of New South Wales.

Radio Equipment for Iran

Redifon, Ltd., has received a contract for a radio network for the Customs Department, Iran. The project involves the supply of complete station equipment, including transmitters, receivers, aerial systems, and ancillary gear. The installation programme will be supervised by Redifon engineers. The order, valued at nearly £100,000, is designed to cover the Department's immediate needs; an extension of the network is planned later. Iranian engineers will visit Redifon's London factory for a course of instruction.

Westminster Street Lighting Contract

The A.E.I. Lamp & Lighting Co., Ltd., has received an order from the London Electricity Board on behalf of the Westminster City Council for the supply and erection of fluorescent street lighting equipment to be installed in Shaftesbury Avenue and in Lancaster Place. Some forty "Mazda" fluorescent street lighting lanterns, each housing four 80 W "new warm white" lamps, are to be mounted on specially designed steel columns carrying the Westminster City Council monogram on a cast iron base. The resulting illumination will be in the region of 16,000 lumens per 100ft of roadway. The installation is scheduled for completion by the end of the year. The erection contractors are Clough Smith, Ltd.

Liner's Laundry Equipment

Hold-ups experienced in dealing with passengers' laundry owing to the time taken to dry clothes, have now been overcome on the Canadian Pacific's steamer *Empress of Britain*.

Laundry equipment on the "Empress of Britain"

The laundry is now equipped with English Electric tumbler dryers and Bendix washing machines, and this has solved the problem. The dryers were put on board during the vessel's recent visit to Liverpool.

Batteries for Indian Substations

Two 132 kV outdoor substations recently built by the Uttar Pradesh Government as part of India's electrification schemes have alkaline batteries for switchgear operation and general services supplied by Nife Batteries, of Redditch, Worcs. Situated at Moradabad and Roorkee, the substations are both equipped with two 110 V batteries, each consisting of 92 low resistance cells. The capacity is 140 Ah at the 5-hour rate. Associated charging and control equipment was also supplied by Nife Batteries. Duplicate batteries are installed so that one can be charged while the other is connected to the load.

Dounreay Contract

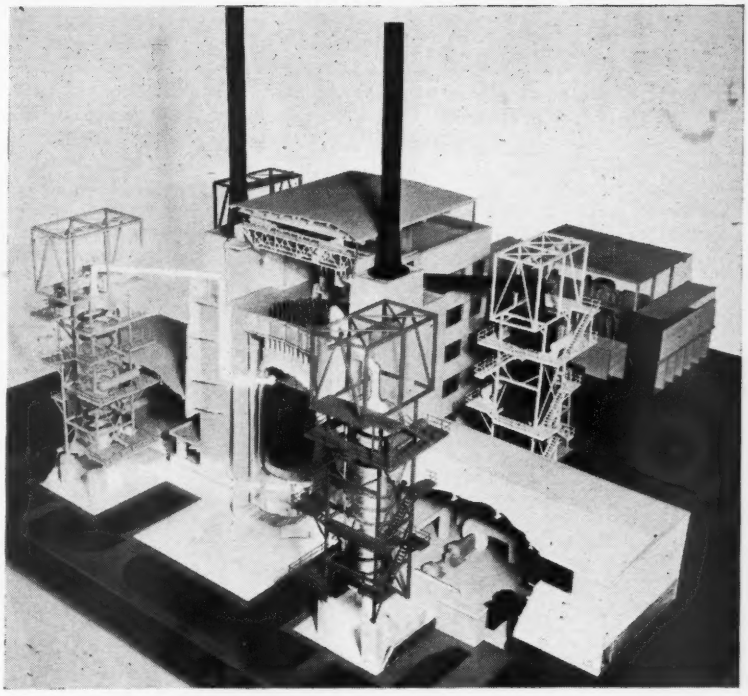
The Tube Investments Atomic Energy Liaison Office announces that a contract has been placed with the TI company, Accles & Pollock, Ltd., to produce the fuel element sheaths for the Dounreay experimental fast fission reactor. The company states that the order, which requires the production of niobium (or columbium, as it is more generally known) and vanadium tubes to extremely fine tolerances, is believed to be the first instance of these metals being fabricated in other than experimental quantities.

Manchester-Crewe Electrification

So that British Railways (London Midland Region) can carry out heavy track work in connection with the forthcoming electrification of the line, passenger train services between Wilmslow and Styal have been suspended until 23rd November. While the work is in progress, trains to and from Manchester will terminate and start from Styal station and special omnibus services will be arranged between Wilmslow and Styal. Nearly 13,000 cu yd of ballast and clay are being removed from the top of ¾ mile of track, so lowering the level of the line to permit the erection of the overhead equipment needed for the new electric service which is to operate between Manchester and Crewe.

Swartwout Training Course

Following the recent agreement between the Swartwout Co., of America, and Elliott Brothers (London), Ltd., for the manufacture and marketing of Swartwout "Autronic" transmission and control equipment the first of a series of instructional courses on the new equipment was held from 1st to 5th October at Elliott Bros. Century Works, Lewisham. The course covered both theoretical and practical aspects of electronic control systems. Among those taking part were representatives of I.C.I., Esso Petroleum, C.J.B. Procon, Caltex, Foster Wheelers, the Lummus Co., W. J. Frasers and Submarine Cables, as well as a number of representatives of continental firms. At the conclusion of the course a dinner and social evening was held in London at which Mr. G. C. Fairbanks, group manager, Century Works, presided. As a mark of appreciation members of the course presented Mr. S. W. Wade, chief engineer of the Elliott Swartwout Division and chief lecturer, with a dispatch case in recognition of his work during the week.



This excellent explanatory model of Calder Hall "A" nuclear power station was exhibited, with a reproduction of the drawing in this week's issue of the Electrical Review, at Calder Hall during the opening of the station by Her Majesty the Queen

New "Osram" Labels Save Time

A new time-saving method of labelling packs containing "Osram" fluorescent tubes, now being introduced, will enable sales and store-room staff to select tubes from stock quickly and correctly. The labels are fixed to the opening ends of the packs and are printed in two directions so that they can be read easily whether the packs are stored lengthwise or with their ends outwards. Each type and size of tube is denoted by a label printed in its own individual colour to ensure that it is distinguishable instantly.

Paris-Geneva Railway Electrification

French Railways announce that the inauguration of the 1,500 V d.c. railway electrification scheme between Bellegarde and Geneva took place on 27th September and that as a result trains between Paris and Geneva and between Lyon and Geneva are being electrically hauled. The next stages of the larger scheme of French railway electrification to be completed will be that between Dijon and Vallorbe by the end of 1956 and that between Lyon and Nimes, via Avignon, by 1961.

Change of Name

Hirst Electronic Development, Ltd., has changed its title to Hirst Electronic, Ltd.

Simms Group Acquisition

Simms Motor Units, Ltd., has acquired the Industrial Fan & Heater Co., Ltd., of Birmingham, with effect from 5th October.

Trade Announcements

The telephone number of the Luton depot of **British Insulated Callender's Cables, Ltd.,** is now Luton 7603-4.

The **Transformer & Electrical Co., Ltd.,** is moving to a new factory at Honywood Road, Basildon, Essex (telephone: Basildon 20491/3), to which all inquiries should be addressed after 29th October.

The **Brush Group (Southern Africa), Ltd.,** the Brush Group's company in Johannesburg, has moved into new premises at 44-46, Third Street, Booysens Reserve.

Martindale Electric Co., Ltd., has appointed Arthur Williams & Co., 164, Chester Road, Manchester, 15, as its Lancashire sales area representatives.

Peak-Load Generation

IN a paper presented on 18th October before the Diesel Engineers & Users Association, Mr. J. R. P. Smith (Central Electricity Authority) discussed the use of internal combustion plant for peak loads on electricity supply systems. From an analysis of load duration curves of a C.E.A. Division, the author showed that only 21 per cent of installed plant need run continuously to generate 49 per cent of the total kWh. Another 53 per cent would be required for 800 to 7,500 hours per annum to generate a further 49 per cent. The remaining 25 per cent would run for less than 800 hours, with up to 300 start-stop cycles, to produce 2 per cent of the total output, the peaks lasting for only one to five hours at a time.

Diesel engines could be run up and loaded quickly without waste of fuel in preliminary warming. Since the war higher-speed engines had been built with pressure charging in relatively small sizes (up to 2,750 kW) at prices well below those of any steam plant.

Economic comparisons based on fuel costs of peak load sets were valueless, since the financial value of their contribution was related only to the grid tariff. The principal operating cost other than fuel was on account of labour; a skilled operator would normally be employed for 2,156 hours in a year as against less than 800 hours for the plant, and the cost of automatic equipment would probably make its use uneconomic.

Two men could run a shift with up to five sets, the individual capacities of which generally made little difference. Logging readings every half-hour generally involved waste of time and paper. Blackboards permanently ruled could give all the information required on changing shifts and for routine maintenance when used in conjunction with a running-hours counter on the engine. A set of readings taken one hour after starting up and thereafter at three-hourly intervals was found satisfactory. Test runs were carried out periodically during which peak pressures and fuel consumption were recorded. Routine maintenance could usually be done by operational staff, supplemented where necessary by staff from a workshop common to a group of stations. Preventive maintenance to ensure full availability on peak was more important than meticulous attention to fuel efficiency.

A 10,000 kW diesel station of the C.E.A. containing five sets having pressure charging and charge-air cooling was built in 1954 at a capital cost of £36·5/kW, made up of £6 for building and civil engineering, £28 for mechanical plant and £2·5 for electrical plant. Capital charges at 8 per cent p.a. would give an annual figure of £2·92/kW. The station was operated on a two-shift basis throughout last winter by a staff of thirteen. Salaries and wages on operation amounted to £4,315 and on maintenance to £1,988; other works costs, excluding fuel, came to £1,773. Adding capital charges at £29,200 brought the total to £37,276. The station's value, i.e. 10,000 kW at £4·15s/kW (grid tariff), was £47,500, giving a profit on operation of £10,224.

The economic life was assumed to be 25 years, but the progressive installation of high-merit steam and atomic plant might alter this condition. Since transmission-line losses varied approximately as the square of the current, diesels at a distance from a main power station could economically carry load peaks or provide stand-by during maintenance or breakdown of transmission equipment. All diesel plant in the Southern Division was run on an " all or nothing basis," the normal loading being 85 and 95 per cent B.S. 12-hour rating, which could be increased over short-period emergencies.

When starting and loading new plant, the engine was normally run up to two-thirds speed and, after one minute idling, raised slowly to full speed. One-third load was given for five minutes and two-thirds for a further five minutes. In emergency a set could be on load in five minutes instead of the usual quarter of an hour. Electric immersion heaters (6 kW for each 1,000 kW set), thermostatically controlled to cut in at 45 deg F, had been fitted to sumps and cooling water circuits to facilitate starting after a cold week-end; the annual consumption was between 1,000 and 2,000 kWh per set. Linear wear for standby duty ranged from 0·0016 to 0·0031in per 1,000 hours. Class B (marine-diesel) fuel with straight mineral lubricating oils were used in the older plant and Class A fuel with H.D. lubricants in the new. In the latter case all the lubricating oil was changed after the first 250 hours' running and the rate of deterioration subsequently had suggested the desirability of a change after each 1,000 hours.

The Submarine Cable

WHEN he delivered his inaugural address as chairman of the London Graduate and Student Section of the Institution of Electrical Engineers in London last week Mr. K. W. E. Gravett dealt with the history of the submarine cable. He said that thoughts of a cross-Channel telegraph cable had started as early as 1840, and initial experiments in Swansea Bay in 1844 showed that a submarine cable was possible. Difficulties in covering a wire with gutta-percha material were solved by 1848 and in the following January two miles of a cable were experimentally laid out into the Channel and signals were sent back from this through the South Eastern Railway Company's land line to London, 85 miles away. The achievement of laying the first Channel cable, however, fell to the brothers Jacob and John Watkins Brett.

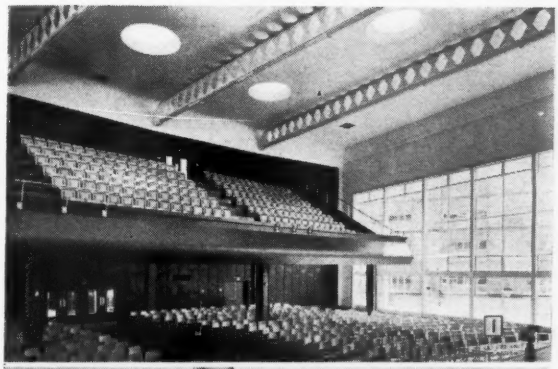
By 1856 further telegraph cables were laid in Europe and had also been laid in the Eastern States of America and Newfoundland. When the first Atlantic cable was laid in 1858 it failed within a few weeks and it was not until 1864 that a further Atlantic cable was considered, and this was the subject of much research and more care in manufacture. By 1866 there was cable communication across the Atlantic, and the success of this gave confidence to other enterprises, including in 1870 a cable from Gibraltar and Suez to India and Singapore and eventually to Australia. The link round the world was completed in 1902 with the trans-Pacific cable. Since then an important development was the continuously loaded cable, laid in 1926 across the Atlantic. Continuous loading speeded up telegraphy and this technique was considered for a single-circuit Atlantic cable in 1928, but for economic reasons this could not be completed.

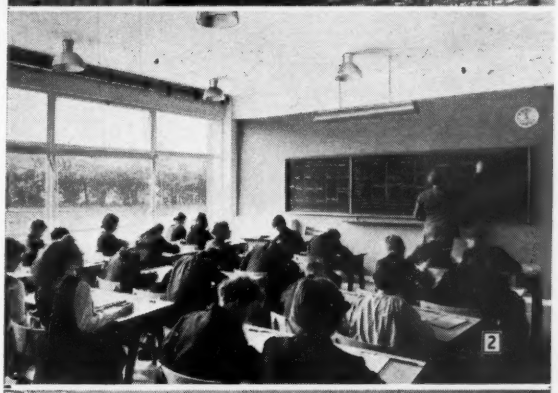
Telephone cables had been laid at the end of the nineteenth century, the first across the Channel in 1891, and loaded cable was laid as early as 1910. To reduce capacitance paper insulation had been used, first in the Anglo-Dutch cable of 1924. In 1921 the first coaxial telephone cable was laid in American waters, and the first carrier cable system was provided in 1926 between Catalina Island and the mainland of California. The large post-war demand for international circuits was met by carrier systems, including the 1947 polythene air spaced cable. It was to the credit of the British Post Office that the first submerged repeater was laid by them in 1943. Intensive development of repeaters on both sides of the Atlantic had led to the recently commissioned Atlantic telephone cable. The field for submerged repeaters was now a very live one and it looked as if the world would soon be thinking in terms of repeatered telephone cables rather than the old telegraph cables, although repeaters were now used also in these to increase their capacity.

Large School Installation

WELL-EQUIPPED ALL-ELECTRIC KITCHENS AT ELTHAM GREEN

Eltham Green Comprehensive School : West Court





1. *The assembly hall seen from the stage.* **2.** *A typical classroom.* **3.** *Staff common room*

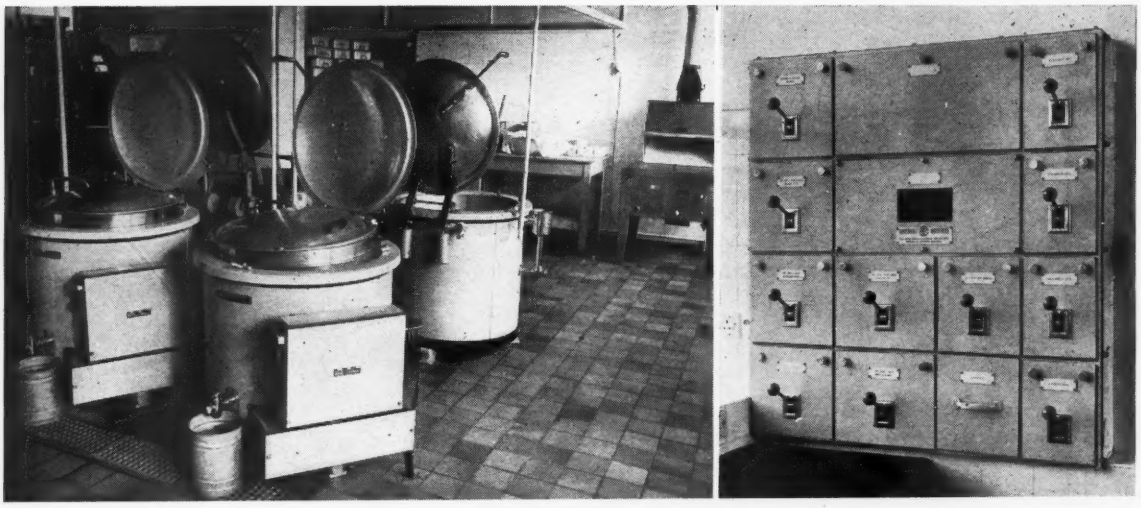
TWO years ago the London County Council's first comprehensive secondary school was opened at Kidbrooke, Greenwich. The latest school of this type is at Eltham Green, Woolwich, where an imposing multi-storey building has been erected, the aim being to leave as much as possible of the limited site area for playing fields. As at Kidbrooke, the school is designed for 2,000 pupils. In addition to academic and general education there are specialist courses in engineering, catering and commercial studies. The school, which has cost approximately £687,000, was designed by Dr. J. L. Martin, architect to the L.C.C.

All the accommodation except the workshops and gymnasia is concentrated in a seven-storey block of splayed "H" form grouped around a spacious central concourse and assembly hall; the latter, which includes a balcony, can seat more than 1,200. There are four lifts at the intersections. The workshops and five gymnasia are in detached buildings.

Oil-fired boilers are used for heating and domestic hot water supplies, but the two main school meals kitchens are all-electric and the extent of the electrical services generally is indicated by the fact that the total connected load is approximately 1,030 kW. The specification for the electrical installation was prepared and the work supervised under the direction of Mr. J. Rawlinson, C.B.E., M.Eng., M.I.C.E., M.I.Mech.E., chief engineer to the L.C.C., assisted by Mr. C. A. Belcher, M.I.E.E., divisional engineer, and Mr. R. Plummer, M.I.E.E.

The supply is brought into an Artic cubicle type intake panel at 415 V, three-phase, the distribution being by p.i.l.c. and s. cables which, for lighting and general purpose circuits within the main building, terminate in Henley risers feeding main distribution boards on the various floors, thence by p.v.c. cables in conduit to sub-distribution boards, h.r.c. fuses being employed throughout. Sub-circuit wiring consists of p.v.c. cables in screwed h.g. welded conduits, and m.i.c.s. cables, feeding some 2,350 lighting points, 460 outlets (including 435 13 A socket outlets), 137 impulse clocks, 46 fire alarm points and 127 radio points.

Lighting in the standard classrooms follows a general pattern of nine 150 W lamps in 14in plastic dispersive



Group of boilers (left) and kitchen control panel (right)

reflectors with a special chalkboard fitting having four 60 W lamps. In the art and craft rooms there is a combination of "warm white" and "colour matching" fluorescent lamps and in the commerce, needlework and biology rooms "natural" fluorescent lamps are used.

Twenty four-tube B.T.H. fittings with 68oft of 120 mA "new warm white" tube provide the main illumination in the assembly hall, the under-balcony lighting consisting of recessed tungsten fittings together with 170ft of 60 mA tube in five four-tube fittings on the high portion of the ceiling. The platform is illuminated by tungsten fittings recessed into the acoustic reflector, additional illumination being provided by four Strand Electric spotlights at the rear of the balcony. The whole of the assembly hall lighting is controlled by push-button operated contactors.

Recessed tungsten lighting is installed in the separate drama hall, the stage equipment comprising four front-of-house spotlights, two magazine battens with interspersed spotlights, a magazine for alternative footlight or ground-row use, and portable wing floods, the installation being controlled by a Strand Electric dimmer panel of the "Junior Sunset" type.

In each general classroom one or two 13 A socket outlets for visual teaching aids are installed and supplementary heating by 2 kW panel fires is provided in staff rooms and offices. Housecraft rooms are equipped with ample socket outlets for the connection of irons, washboilers, washing machines, refrigerators and points for cookers and a wide range of equipment of this type is in use.

In the chemistry, physics, biology, and general science rooms low-voltage terminal units are provided on the benches, making available for experimental purposes 0-18 V a.c. or d.c. from a unit specially designed by the L.C.C. Chief Engineer's Department. In the art room there is a 12 kW pottery kiln.

School meals kitchens are situated on the third and fourth floors and are connected by two food lifts to serveries on all floors from ground to fourth inclusive. All apparatus is electrically operated, each kitchen being controlled by an Artic cubicle type panel arranged for flush mounting and provided with rear access. The total installed load of the kitchens and serveries is approximately 390 kW, the sub-circuit wiring being mainly in m.i.c.s. cables.

The equipment in each kitchen includes a Jackson double-oven range (31 kW), two Jackson two-tier roasting ovens (11 kW each), three Simplex "Creda" 6 cu ft

Two-tier roasting oven, double-oven range and rear of two steaming ovens

steaming ovens (9 kW each), one Falco and three Stott 30 gal boiling pans (14 kW each), a Bartlett fish fryer (9 kW), a Hobart potato peeler and a mixing machine of the same make, an Ultra Rapid vegetable preparing machine, a Metcalfe meat slicer and a 25 cu ft Prestcold refrigerator. The fourth floor kitchen includes a 100 cu ft Marco refrigerator, and both have Keith Blackman "Tornado" extract fans. In the serveries there are two Gardiner & Gulland hotcupboards (5 kW each) and a rinsing sink with Santon 6 kW element.

In addition to the food lifts, four 30-person lifts and one 7-person passenger/goods lift have been installed.

Boiler house power circuits are provided for eleven circulating, fire booster, oil transfer, and sump pumps, two induced draught fans, and flue extract fans, and three automatic oil-fired boilers, together with the associated safety and alarm circuits. These are wired throughout in m.i.c.s. cables. The heating plant and the plenum system are centrally controlled from a cubicle type panel in which the control and recording instruments are also grouped.

The five workshops are equipped with lathes, millers, grindstones, drills, forges, etc., each shop being fed by a three-phase ring circuit controlled by a t.p. and n. oil-immersed circuit-breaker, the trip circuit of which is controlled by emergency stops placed at strategic positions.

In all teaching rooms and offices, etc., half-minute impulse clocks are installed, the system being controlled

by a master clock in the radio room. The combined broadcast, class changing, public address, and fire alarm system, which was devised by the L.C.C. Chief Engineer's Department, consists of a central bank of broadcast receivers and amplifiers feeding loudspeakers in classrooms, etc., a local selector switch/volume control being provided to enable any one of three class changing signals to be selected. The signals are electronically generated and regulated by a programme controller operated from the impulse clock system. The 400 c/s fire alarm signal is produced from a battery-operated motor generator and is imposed directly on the loudspeaker wiring without amplification. The order of signal priority, which is automatically selected, is: (1) fire alarm, (2) public address, (3) class change, and (4) schools broadcast.

The fire alarm wiring has been utilised to provide an internal staff communication system which comprises a desk type amplifier in the central office together with loudspeaker/microphone units at each of 30 selected fire alarm positions.

The sub-contractors for the electrical installation were H. J. Cash & Co., Ltd., and for the stage engineering equipment W. J. Furse & Co. (London), Ltd., Clark & Smith, Ltd., being responsible for the radio and staff communications system and Hammond & Champness, Ltd., for the passenger and goods lifts. The suppliers of the principal equipment included the Artic Fuse & Electrical Mfg. Co., Ltd. (main intake and kitchen panels), Dewhurst & Partner, Ltd. (boiler house panel), the Strand Electric & Engineering Co., Ltd. (stage dimmer panel), the Synchronome Co., Ltd. (impulse clocks and programme controller), and Gent & Co., Ltd. (fire alarm system).

Telecommunications—Past and Present

Post Office Electrical Engineers' Jubilee Meeting

Brig. L. H. Harris, president of the Institution of Post Office Electrical Engineers

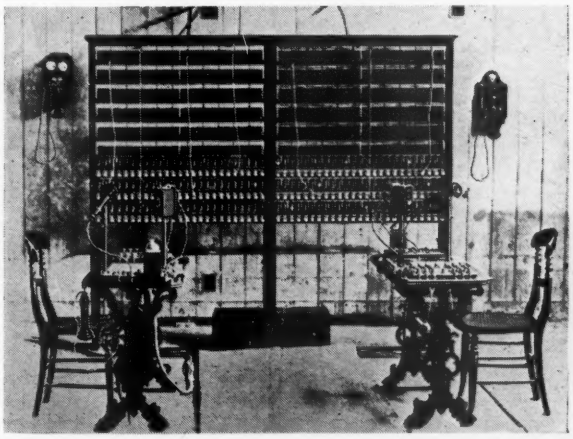
THE jubilee of the Institution of Post Office Electrical Engineers was celebrated on 8th October when its president, Brigadier L. H. Harris (Engineer-in-Chief, G.P.O.), gave an address on "Fifty Years of Telecommunications." After a comprehensive survey of early developments, illustrated by lantern slides, he turned to more recent advances in telephony which, he said, had been made possible on the present scale only by automatic working. In the U.S.A. 1½ million girls would be required to operate the system manually instead of the actual 280,000. The Strowger system adopted in Britain was easy to understand, an outstanding advantage when technical knowledge was undeveloped. Conversion to automatic exchanges, which started at Epsom in 1912, was first put in hand on a full scale at Holborn in 1927, when the total number of subscribers was about one million.

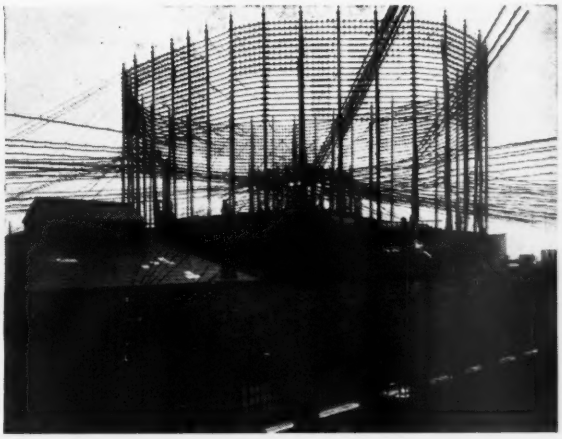
On the radio side, the Post Office and Marconi's separately had set up coastal stations, which were taken over by the P.O. in 1909, but the initiation of the Imperial Wireless chain was held up by the war until 1921. In 1927 the establishment by the P.O. of short-wave beam stations, developed by Marconi's, seriously affected cable receipts and because of the strategic importance of the cable network integration was carried out by the formation of Cable & Wireless, Ltd. Radio telephony stayed with the P.O., which had since 1951 been responsible for all United Kingdom radio terminals concerned with civil telephone and telegraph traffic, while Cable & Wireless operated many of the overseas cable and radio terminals.

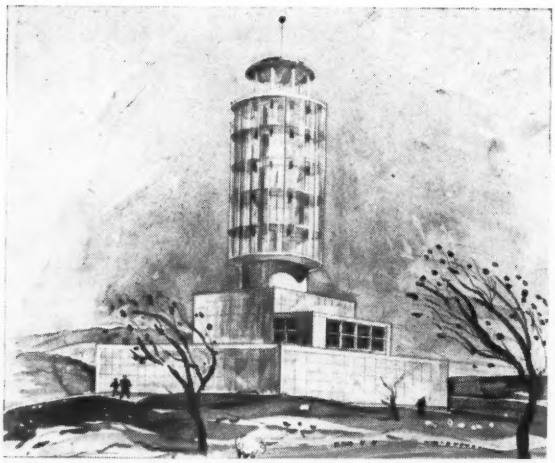
The Rugby station opened in 1925 was the first to use high power valves. Two years later, in co-operation with the American Telephone & Telegraph Co., it was the first transatlantic radio telephone system, using single sideband suppressed carrier working for the first time. The extension last year was world-wide in its coverage and with centralised control and remote switching was probably the largest and most modern and economic station anywhere.

In 1915 a London-Birmingham underground cable of 52 pairs used 760 tons of copper despite the use of loading

Left: The first public telephone exchange in the United Kingdom was opened at 36, Coleman Street, London, E.C., in 1879.
Right: Roof standard at the National Telephone Co.'s Avenue Exchange







Impression of the type of building that could be used for the multi-broadband radio relay of the future (Photograph by courtesy of the Ministry of Works)

coils (first introduced in 1901), whereas to-day 1,000 telephone circuits should be obtainable for this amount of copper, the cost of which, allowing for the decreasing value of money, was 3½ times that of 1946. The thermionic valve was the main factor in securing economy of copper and in 1920 the telephone repeater was far enough advanced to justify a decision in favour of the future use of light gauge loaded conductors with repeaters for trunk circuits. Carrier systems followed, economising in the number of repeaters. Dry plate rectifiers (1930) greatly influenced circuitry and also the use of a.c. mains supply, which could be changed over to local supply in the rare event of mains failure. Recently a new telephone instrument had been developed which would permit either further savings of copper or larger exchange areas.

For telegraphy a voice frequency (12/18 channel) was introduced in 1932 to suit the natural keyboard speed of teleprinters and after the war the conversion of manual switching to automatic, using Strowger switches, was completed. A similar conversion of the Telex service was now projected, which was expected to continue to expand from its present service to 3,000 subscribers.

After the war priorities of money and manpower were given to exports and housing, so Post Office policy was directed towards safeguarding the future by building up the trunk system (including subscriber trunk dialling) and fostering research and development.

Good wishes for the future welfare of the Institution of Post Office Electrical Engineers were received from the Institution of Electrical Engineers through its president, Sir Gordon Radley (Director-General of the Post Office), and from industry through Sir Thomas Spencer (Standard Telephones & Cables, Ltd.). The membership of the Post Office Institution was stated by Mr. D. A. Barron (chairman of the Council) to be about 6,000 compared with 750 in 1906.

A historical exhibition of apparatus was arranged at the Institution of Electrical Engineers.

Future of Management

THE title of the address by Mr. H. Robson as chairman of the Southern Centre of the I.E.E. was "Management—The Prospect Before Us." Commencing by quoting *dicta* by Professor E. B. Moullin and Lord Citrine on the subject, Mr. Robson said that the first drew attention to the centralisation of administration to the exclusion of the ideals of the professions and the second blamed engineers for not equipping themselves for management.

The trend towards centralised administration was seen equally in nationalised bodies and in public companies and cartels. In their early stages, at least, the organisations followed a pattern and as an example Mr. Robson took the Area Board organisations of the electricity supply industry. In the formulatory periods of these organisations management was operated from headquarters through specialist functional control and the tendency was to disregard local interests to secure uniformity. This led to a lack of opportunity of applying a human outlook and an understanding of people.

Mr. Robson said that while an operational manager legally derived his authority from a single source, there were six factors which had to be considered. First, there were policy directives and instructions from the controlling body but a system of management based on administration alone would become too rigid to work. Secondly, in the matter of legislation and regulations the men in charge should be expected to observe them without having their attention specifically directed to them. Thirdly, while terms and conditions of employment were determined nationally, local machinery existed for dealing with local difficulties. Fourthly, there were local advisory committees to deal with such matters as safety, health, welfare, education and efficiency. Fifthly, there were local traditions, practices and conventions. Finally, there were consultative and advisory councils representing consumers' and general public interests. While it might at first be temporarily necessary to put the last three into a secondary position they could not be permanently repressed.

A "rule of law" in which the maker of the law administered it and adjudicated upon it was dictatorship. As in government in the control of industry there should be a separation of powers into overall control, operational management and functional management. After defining these Mr. Robson said that safeguards were provided by advisory committees, local traditions and consumer demands. It might be thought that standardisation could only be achieved centrally and flexibility locally but there was no reason why actions taken locally should not conform to a general policy and be effective. There was a parallel in the development in the administration of justice over the centuries by which we now had a flexible and workable system where once there was rigidity and friction.

Mr. Robson next dealt with the extent of background knowledge and the ability to profit from it possessed by managers. He classified this under seven heads:—Knowledge required to deal with different situations as they arose—or to prevent them arising; judgment of the proper time to make changes; a sense of proportion; skill in dealing with difficult situations and people; ability to get at the truth; persistency; and consistency.

Reference was next made to the possible danger of administration becoming an end in itself at the expense of production. As a safeguard it was necessary to secure managers with a sound training in the basic activity of the business and able to see it as a whole. Specialisation was narrowing the look of technical minds and the correcting factor must surely be a combination of technical knowledge with general knowledge and humanistic traditions.

The Electronic Age

I.E.E. Radio and Telecommunications Section Chairman's Address

IN his inaugural address as chairman of the Radio and Telecommunication Section of the Institution of Electrical Engineers on 17th October, Dr. Robert C. G. Williams appeared to set out to disprove what is so often expressed, that we know very little of what electricity really is. He said we had developed an accurate mathematical basis for its behaviour and could use this to design and predict the operation of large engineering projects.

The 19th century saw the beginnings of the atomic age in which we first began to visualise the atomic structure of matter and to utilise more fully the chemical and metallurgical properties of the natural raw materials of the world. Logically, he said, we could describe the 20th century as the sub-atomic age in which we had begun to understand and make use of the sub-atomic particles. The electron happened to be the most easily freed and the most mobile of the sub-atomic particles and the electrical profession had identified itself with it. Basic effects such as the conduction of metals, the capacitance effects in insulators, the piezo-electric phenomena in certain crystals, photo-electric and photo-conductive devices, phosphors, and the newer transistors and ferrites were all concerned with the solid state, and there seemed to be no reason why many more interesting applications should not be ahead of us.

Growth of Radio Industry

Although the thermionic valve dated from 1904 it was not until the first world war that production took place in any quantity and permitted the generation of continuous waves suitable for communicating speech and music. The radio receiver industry had been unique in growing out of the already established component industry. Census of production reports for 1950 and 1935 gave the following gross outputs for the radio and telecommunication industry compared with other industries:—

	1950 Gross outputs £ million	Ratio 1950/1935
Radio and telecommunication	137	4·9
Motor vehicles and cycles	669	5·1
Brewing	427	3·5

A recent estimate was that the electronic industry required about 1,000 professional engineers and 4,000 to 5,000 technicians a year. As this represented nearly 30 per cent of the present output of graduates it was worth while reminding ourselves of the overall comparison with our chief competitors:—

	Number of graduate engineers a year	
	1950	1954
U.S.A.	50,000	20,000
U.S.S.R.	28,000	54,000
U.K.	3,600	3,400

From a manufacturing viewpoint artificially produced semi-conductors presented a problem in controlled impurity as distinct from the classical chemical problem of controlled purity. In production the basic material must first be purified to a degee far beyond normal manufacturing tolerances, and to this pure material must be added microscopic amounts, of the order of one part in 10^6, of an equally "pure" impurity. Many ingenious methods were being developed for growing pure crystals and subsequently treating them by "zone refining," and electronic methods of measuring their purity were available, but it was a process which required pharmaceutical standards of cleanliness and a fundamentally different outlook in the factory.

Transistors and Valves

Most of our electronic work has been concerned with electron flow in a vacuum—the so-called free electron—and in devices, such as transistors, making use of semiconductors we were replacing this vacuum by an artificially produced crystal lattice. The material was difficult to control and inspect for flaws and variations and as these were inherent in the medium it provided a problem likely to be with us for some considerable time. The manufacturing problem rested in mass production to consistent tolerances and at a process cost which would take advantage of the low material cost. Discussion on whether transistors would entirely replace valves was, he felt, rather pointless—both devices had their place and were likely always to exist side by side, with the transistors taking over where small size, low power consumption and long life were of importance.

Chemically, ferrites had a formula MFe_2O_4, where M was any divalent metal. Physically, they had the characteristics of ceramics and in fact were spoken of in manufacture as "black ceramics." Their great advantage over earlier materials was their low high-frequency losses. Three of their applications derived from the forms of hysteresis loop which they could be made to exhibit. These were:—

(*a*) Material with high permeability and a "thin" hysteresis loop had extensive application as a core for high-frequency coils.

(*b*) Material with high remanence and a "fat" hysteresis loop was suitable for use as a permanent magnet which yet had low losses in a radio-frequency field.

(*c*) Material with a hysteresis loop with steep sides and roughly rectangular in shape led to what were known as "square loop" applications for use as a "memory" in computer work.

Transistors and ferrites had obvious applications to mobile and portable apparatus where the saving of battery weight or the use of an already available low-voltage supply was attractive. Television was heading for a place in every home and for an important part of our export business. The sizes of the cathode ray tubes for these receivers had been steadily growing, from the 9in and 12in tubes with which we started to the present emphasis on 17in and 21in tubes.

Dr. Williams thought it was true to say that without the recent developments of electronic engineering, atomic power would never have been possible. Even more important was it role in future power production with its attractive possibilities of deriving electrical energy direct from atomic fission and fusion effects without the intervention of the heat engine. Radioactive isotopes and their associated measuring instruments brought a new and powerful research tool to the agriculturalist, medical man and engineer, while high energy particle accelerators and electronic devices were of increasing application to medical therapy.

Industrial Influence on Public Electricity Supply

2. The Textile Industry

By W. E. SWALE, M.I.E.E., A.M.I.C.E.

Cotton mills built at the height of Lancashire's prosperity (by courtesy of Irwell Bank Spinning Co., Ltd.)

OF the nine million or so people employed in the manufacturing industries in the United Kingdom in August, 1955, over 10 per cent were engaged in some form of textiles. The *Monthly Digest of Statistics*, published by the Central Statistical Office, gives the sub-divisions indicated in Table I which illustrate the scope and relative importance of the various branches covered by the collective heading " Textiles."

These figures indicate a substantial industry which is of vital importance to home and export trade alike, and is bound to have some influence on public electricity supply. This article covers the items listed above, with the exception of the manufacture of rayon and other " synthetics," because this is mainly a chemical process, and it excludes the hosiery and knitting industries as these differ greatly from the traditional textile processes.

Compared with the newer engineering and chemical trades the textile industry in this country is very old. Most factories were originally driven by steam engines, and traces of water power can still be found in quite a number. It is no wonder therefore that the building of new mills is entirely overshadowed by the problems of modernising existing ones. In either case electricity exercises a vital influence.

The total number of employees in all branches of textiles in this country is slowly growing. Yet the world total of cotton spindles has decreased by over 12 per cent since 1939. The demand for cotton goods has not decreased substantially. In 1953 the world population of approximately 2,500 million people bought roughly 9 lb per head of apparel fibres, of which total 71 per cent were cotton, 11·3 per cent wool, and 17·7 per cent rayon or other man-made fibres. It can only be assumed that the growing number of more efficiently equipped mills, many of them working two or three shifts, is offsetting the overall loss of spindles.

Unfortunately for Great Britain, and for Lancashire in particular, the building of newer and more productive mills is taking place almost entirely abroad—in some European countries, in America, in Africa and particularly in India. The tendency, a natural one, is to erect spinning mills much closer to the sources of raw cotton. The unpalatable fact must be faced that the days when Lancashire spun and wove for the whole world are gone for ever (compare exports of cotton piece goods—7,000 million square yards in 1913, as against 700 million square yards in 1955). It is a question of concentrating on smaller markets where originality and quality permit greater profits. In this connection the rapid development of the newer man-made fibres is highly encouraging, but it cannot prevent the gradual contraction of the British cotton business.

The photograph which heads this article reveals two problems, the general one of the electrification of an old mill, and the particular one of the survival of mule

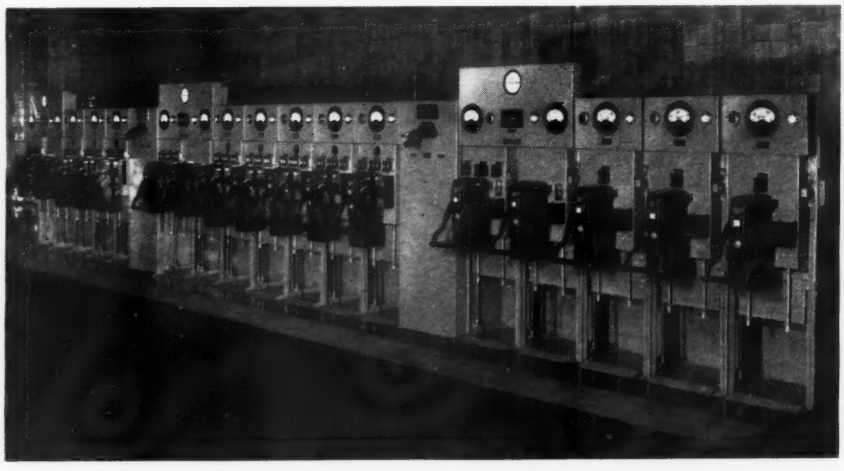


Fig. 1.—Main 415 V switchboard in old engine room of No. 2 mill (by courtesy of Erskine, Heap & Co., Ltd.)

spinning. The two mills were built (No. 1 in 1894 and No. 2 in 1904) to house about 285,000 mule spindles and formed one of the largest units in the country. They symbolise the confidence of the Lancashire cotton spinner towards the turn of the 19th century. About ten years ago No. 1 mill was changed over from steam to electric driving. In 1952 serious trouble with the 2,500 i.h.p. triple-expansion engine in No. 2 mill necessitated a further quick conversion. Group driving was adopted in both mills in the card and mule rooms but much of the preparation machinery is now driven individually. In No. 2 mill, for instance, slip-ring motors, ranging from 300 to 400 h.p. each, at 490 r.p.m., drive direct on to the main shafts of the mule rooms. Fig. 1 shows the main 415 V switchboard mounted in the old engine room of No. 2 mill. Each of the three sections of this board is connected to a 1,000 kVA transformer and there are two busbar couplers. Each of the eight l.v. oil circuit-breakers on the left-hand side of the board controls the stator of a large motor and switches on the panels permit of remote operation of the liquid starters, though these can also be operated by hand. Automatic power factor correction is incorporated. All the oil switches are A.S.T.A. tested with rupturing capacities of 25 MVA.

In common with many other mule spinning mills this company is concerned with the future, in view of the fact that mule spinning, particularly of cotton, has virtually died out in other countries. A number of ring-spinning frames have now been installed and a comparison of the two methods of spinning can be made under practically identical conditions. The employment of female labour on the ring frames, in place of the male mule spinners, who represent a dwindling labour force, is often a strong argument in favour of this type of re-equipment.

Fig. 2 shows the driving ends of a number of Platt ring frames of 420 spindles each. Each frame is driven by a 9 h.p. 1,450 r.p.m. t.e.f.c. motor of the B.T.H. smooth-acceleration type. The motors are controlled by direct-on-line push-button operated contactor starters supplied by Erskine Heap. The installation was carried out by Fergus Makin, Ltd., Manchester, under the supervision of the mill engineer, Mr. W. F. Skerrett. The total horsepower of motors installed in these two mills is 3,750 h.p. and the maximum demand is about 2,120 kW.

Magnitude of the Cotton Load

Table II sets out the results of a census taken in 1945 of the horsepowers in use in the Lancashire and Cheshire cotton industry.

How much of the half-a-million or so horsepower of private plant will eventually go over to public supply is a question which cannot yet be answered. Problems of which mills to scrap and which to re-equip in pursuance of the policy of striving for " fewer and better mills " are foremost in the minds of cotton spinners. Of Lancashire's remaining 25,000,000 spindles " in place " (only 60 per cent of these are at present running) over 50 per cent are still mule spindles. A large number of these may not warrant changing to electric driving. Between 80 and 100 spinning mills have been closed down in recent years and as the majority of these were driven by steam the loss of actual load to the supply industry was not significant but the loss of potential new load is appreciable.

Weaving and finishing, together accounting for less than 30 per cent of the total power requirements, offer good prospects for electrical development. The steady increase in the use of man-made fibres, which are still processed to a large extent on conventional cotton machinery, offers a continuous challenge to all three sections of the trade, who must be ready for rapid changes in technique to meet

Fig. 2.—New ring-spinning frames driven by 9 h.p. smooth-acceleration motors (by courtesy of Irwell Bank Spinning Co., Ltd.)

the latest developments both in research and in fashions. Problems involved in the union of cotton and wool with man-made fibres appeal to the peculiar genius of the British textile technologist. The lead of this country is however likely to be only temporary, and the market for these fairly expensive quality materials will always be small compared with the world demand for cheap and highly competitive products.

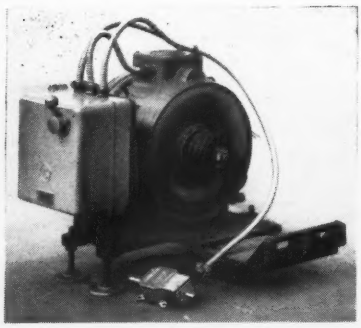
Of the 350,000 looms now working in this country only about 12 per cent are of the fully-automatic type. In the United States the change to fully-automatic weaving is practically complete; throughout the textile world the percentage of fully-automatic looms is to-day over 30 per cent. The cotton and cotton-rayon trades have therefore a great deal of leeway to make up. Automatic looms are expensive, and can only be justified on the basis of two- or three-shift working, but they are the only way to any considerable increase in productivity of woven cloth. There are still many thousands of Lancashire looms driven by line-shafting and steam engines. As the advantages

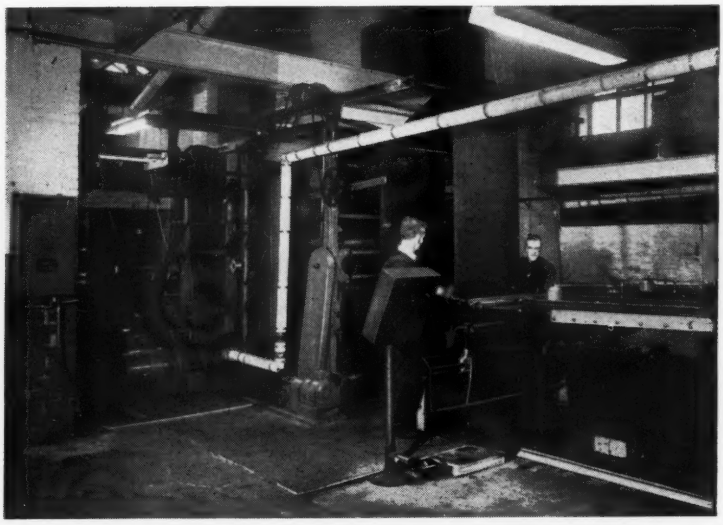
TABLE I

Item	Trade	Men & women employed (thousands)	Percentage of total in textiles
1	Cotton-spinning and doubling	149·2	33·5
2	Cotton-weaving	113·5	
3	Cotton-finishing	53·5 (est)	
4	Woollen and worsted (all sections) ...	207·7	22·0
5	Rayon and nylon production, *and* silk manufacture	91·4	9·6
6	Hosiery and other knitted goods ...	125·4	13·3
7	Textile finishing (excl. cotton, which is included under 3)	35·7	3·8
8	All other textiles, e.g. flax and jute ...	168·3	17·8
		945·3	100·0

TABLE II

Section	Private plant b.h.p.	Public supply b.h.p.	Total b.h.p.	Per cent of total power
Spinning	424,525	205,125	629,650	73·0
Weaving	113,150	43,725	156,875	18·0
Dyeing & finishing	35,605	41,955	77,560	9·0
TOTALS ...	573,280	290,805	864,085	100·0





Above: Fig. 3.—Motor, contactor starter and three-point pilot switch used in converting a Lancashire loom to individual driving (by courtesy of the North Western Electricity Board, No. 5 Sub-Area) and (right) Fig. 4.—Modern cloth stenter driven by two variable-speed a.c. commutator motors (by courtesy of Henry Cochrane & Son, Ltd.)

of individual electric driving are particularly marked in weaving it is expected that for years to come there will be a steady business in converting these older steam driven weaving sheds. Automatic looms are electrically driven as a matter of course. Fig. 3 illustrates a conversion unit which has been developed by the engineers of the No. 5 Sub-Area of the North Western Electricity Board to meet a peculiar local problem. The total cost of conversion is about £50 per loom and the work can be carried out speedily.

Whereas spinning is still carried out in large units of 50,000 spindles upwards, and the average spinning mill has demands ranging from 1,000 to 2,000 kW or even more, weaving is done in smaller establishments with equipment ranging from 200 to 1,000 looms. The overall demand of these weaving sheds ranges from 150 to 600 kW.

In the finishing trade the multiplicity of processes and machines and their spread over a fairly wide floor space favour individual driving. Dyeing, which was formerly done in the cloth alone, is now increasingly carried out on rayon fibre, rayon cakes, and spun yarns in cop, cheese or hank form. This means an increase in pressure dyeing methods and considerable use of electrically driven pumps, hydro-extractors, etc. A feature of this trade is the need for a wide range of speeds on many of the machines, especially in cloth stentering ranges and printing machines. Fig. 4 illustrates a typical modern stenter of 60ft length. The machine, made by Mather & Platt, Ltd., has a range of cloth speeds from 20 to 100 yd/min. It is driven by two B.T.H. variable speed commutator motors of 30 h.p. and 10 h.p. respectively whose speed can be varied from 1,500 to 300 r.p.m. The trend in modern finishing ranges is towards higher cloth speeds and greater adaptability in meeting the frequent changes which are demanded to-day.

Proportion of Total Industrial Load

Figures supplied by the North Western Electricity Board indicate that at the present time about one-third of their large industrial consumers are classified under the heading "Textile." In twelve months the energy supplied to this textile group represented about 23·5 per cent of the total supplied to large industrial users altogether. The chargeable maximum demand of the textile group was about 34 per cent of the total industrial demand. The annual load factor of the textile group is appreciably less than that of the whole of the large power users, including many large concerns working on three shifts.

Fig. 5 illustrates, in curve B, the load of a typical spinning unit (actually three mills supplied from a common substation) which operates about 117,000 spindles. The upper curve A shows the load on the relevant grid metering point. It will be seen that the mill load curve follows the general shape of curve A closely, though there is some diversity during the mid-day break and in the evening.

Fig. 6 illustrates the modern type of metering equipment installed by the North Western Electricity Board at the cotton mill in question. The input of each of the two h.v. feeders is metered separately, and readings are summated on the instrument shown in the centre of the panel. On the lower half of the

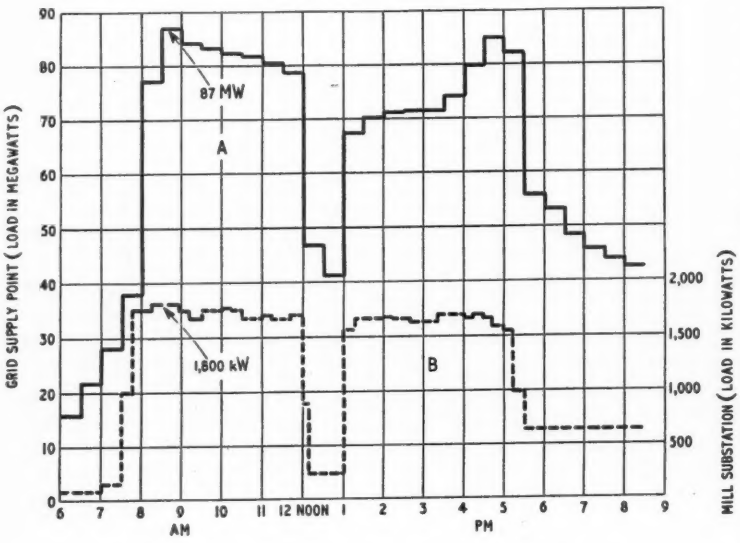


Fig. 5.—Loads at grid supply point and at cotton spinning mill

panel can be seen the Ferranti maximum demand alarm, and the recording wattmeter, a chart from which formed the basis for the construction of curve B (Fig. 5). Before the maximum demand alarm was fitted it was usual for a minor peak to develop around 8 a.m. on very cold Monday mornings in mid-winter. By carefully studying the recorder charts and then installing the maximum demand alarm it has been possible to transfer certain morning loads to a later time of day, and so reduce the maximum demand by between 300 and 400 kW. The installation is a good example of co-operation between the Board's engineers and an enlightened mill management which did not hesitate to spend money on additional instruments when some advantage was to be gained.

One may wonder what effect developments in the cotton industry will have on the load factor of the electricity supply industry. With the present trends it does not appear that the improvement will be great. The possibilities lie almost exclusively in an increase in shift working. Neither the change to ring-spinning and female labour in spinning mills nor the large proportion of women engaged in weaving sheds makes such developments easy. The cotton industry has to deal with strong opposition from within the ranks of its own employees before the coast is clear for a general acceptance of shift working. In the writer's view the necessary changes in the practices and equipment of the cotton industry will not lead to any spectacular growth in electrical load or great improvement in load factor.

Wool Prospects Bright

The woollen industry in Yorkshire, centuries older than cotton, also suffers from a legacy of obsolete machinery and steam driven mills. It differs from cotton in that it depends to a lesser extent on export trade and deals with a more expensive product, in which there is less foreign competition and profit margins are likely to be higher. Progress in electrification has been more rapid and it is estimated that from 55 to 60 per cent of the power needed by the industry is taken from public supply. The general tone of the industry is more optimistic, and a substantial measure of re-equipment has been taking place since 1945. Entirely new mills have also been built. In some of these, which are not in the old-established textile areas, two-shift working with female labour is practised, so ensuring that the very expensive plant is run at a more economic level of output.

Figures recently supplied by the Yorkshire Electricity Board show that about 14 per cent of all their large power consumers are classified as "wool textiles." These consume about 9 per cent of the kWh sales to industry, and make a demand of about 9 per cent of the aggregate industrial demand. It is estimated that since 1950 there has been an increase in consumption by the wool textile users of about 23 per cent.

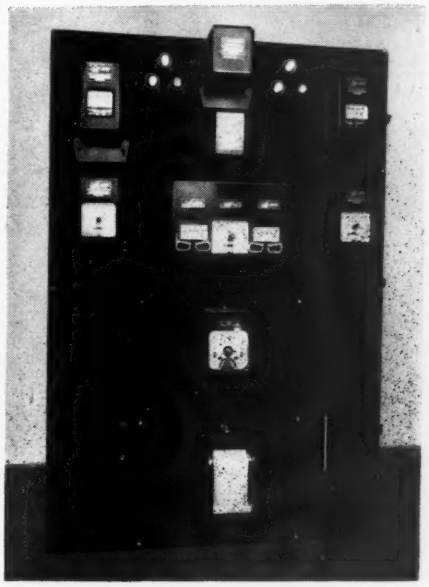
The industry is divided into the worsted and the woollen sections. In the former, which is generally organised horizontally, the various processes of combing, spinning, weaving and finishing are carried out by separate concerns. The raw material is usually a long staple wool, and the end product is a finely spun, compact and smooth yarn. The woollen section uses the shorter wools, the short fibres rejected by the worsted combs, and waste from all sections of the industry. The end product is usually a coarser yarn, which is used for heavy clothing materials. This section is usually organised vertically, i.e. all processes are carried out in one mill.

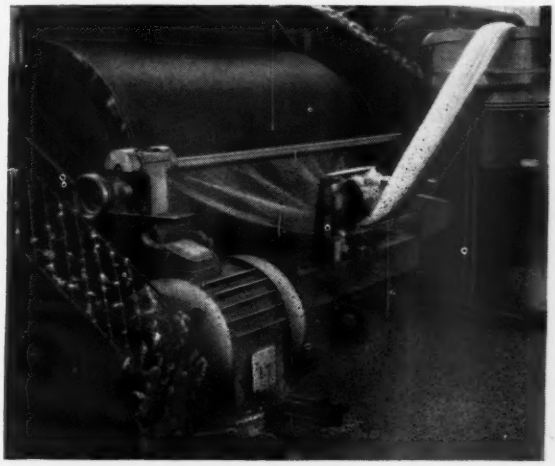
A further feature which distinguishes wool from cotton is the preliminary process of combing. This includes washing, back-washing, and drying in addition to the actual carding, and needs considerable quantities of process steam. It is usual to work the combing plants on two 44-hour shifts, so that annual load factors of between 38 and 50 per cent are commonly recorded.

Wool preparation and spinning machinery takes appreciably more power than is usual for comparable cotton machinery. This can be seen in Fig. 7 which illustrates a wool card, driven by a 8 h.p. motor (in contrast with the 0·5 h.p. motor used on a normal cotton card).

New Works

It is encouraging to hear about new mills which challenge competition with any similar plant in the world. In 1947 Patons & Baldwins opened a new factory in Darlington which covers 40 acres of buildings, mainly single storey. Virgin wool enters the works and is completely processed, spun and dyed, leaving in the form of skeins and balls of knitting wool. The factory employs about 3,500





Left: Fig. 6.—Electricity Board's metering panel with consumers' instruments in lower half (by courtesy of Knowles, Ltd.) and (below) Fig. 7.—Wool card driven by 8 h.p. squirrel-cage high-torque motor (by courtesy of the English Electric Co., Ltd.)

Fig. 8.—New worsted spinning factory at Peterlee, Co. Durham (by courtesy of Jeremiah Ambler & Co., Ltd.)

people, the total load of motors is about 15,000 h.p. and the maximum demand is about 8,000 kW of which one-third is generated in works alternators and the balance taken from the North Eastern Electricity Board. Hot water for wool washing and dyeing is supplied from the works boilers, the load of which can be equalised by thermal storage plant.

A much smaller plant that was opened in 1954 at Peterlee, Co. Durham, by Jeremiah Ambler, Ltd., and is illustrated in Fig. 8, is another example of enterprise in the woollen industry. It is again a single-storey factory working two shifts, and has been designed to produce fine quality worsted yarns. At present the American shortened process is in use, but trials are being conducted which may result in the addition of British built machinery. The factory is designed around the basic principles of productivity, namely, simplification, standardisation and specialisation, and has already justified the methods employed by a ratio of output to operative comparable to that obtained in the best American works.

Linen Manufacture

Although there is an important linen thread and cloth industry in parts of Scotland, the greater proportion of flax and flax-rayon mixtures is manufactured in Northern Ireland, where some 150 textile firms are now at work. These have no direct influence on the British supply industry, although they do provide opportunities for British makers of textile machinery. The total load is said to be about 65,000 kW and a good deal of re-equipment has taken place in recent years.

Jute Manufacture

It is not always realised that jute comes second to cotton in volume of annual production. Several trends, notably the increasing use of jute in making sacks for the chemical and food industries, are causing steadily growing demands and the industry is in a flourishing state. The greater part of the world output of jute is manufactured close to where it is grown, namely, in India and Pakistan, but large quantities are processed in Europe. The industry in this country is mainly centred on Dundee, where it was first started in 1840. At present the annual consumption of the jute spinning and weaving works is about 76,000,000 kWh with an estimated maximum demand of 30 MW. Jute is also manufactured in other parts of Scotland and in Northern Ireland.

Jute processing machinery is highly specialised. It takes considerable power to drive it owing to the length and coarseness of the fibres. Fig. 9 illustrates a circular loom of the Saint Frères type, which is coming into increasing use in the manufacture of hessian sacks. These looms are driven by 3 to 4 h.p. motors, according to the number of shuttles. The shuttles travel around the inside of the loom, and work at about 300 picks per minute, compared with the speed of 70 to 150 picks on the flat jute loom.

A summary of the demands and consumptions arrived at for the three major textile industries is given in Table III.

These figures must be accepted with the obvious reservation that the three Boards mentioned do not supply all the textile load in the country. There are substantial loads in Scotland, in respect of cloth manufacture, and in the Midlands, for instance, in carpet making, but figures are not readily available. When compared with the country's total electrical load (in year to 31st March, 1955, the aggregate maximum demand was 16,255,000 kW and the energy sold to all consumers 62,410 million kWh) the textile load is surprisingly small, even if an increase of as much as 25 per cent is made to allow for the unaccounted

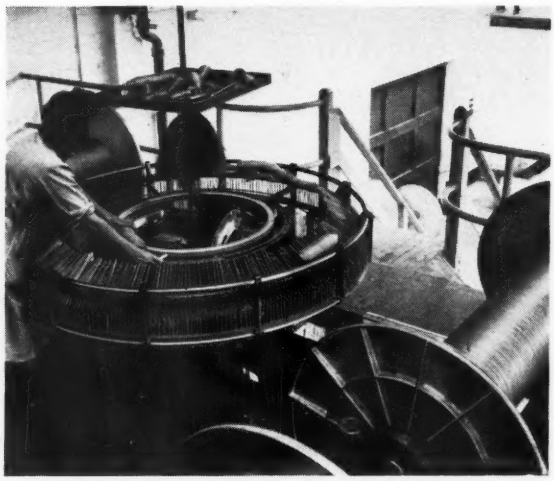


Fig. 9.—Circular loom used in manufacture of jute sacks (by courtesy of Urquhart Lindsay & Robertson Orchar, Ltd.)

load of other Boards. It would be interesting to know the comparable figures for kW and kWh for the items mentioned in the first table, viz. rayon and nylon production and silk manufacture, and the hosiery and knitted goods trades. Electrical requirements in these trades must be substantial and increasing, but no detailed study of the figures appears to have been made.

The Challenge of Plastics

In any speculation about the future of cotton the impact of the newer plastic materials cannot be ignored. For several thousands of years the basic method of making cloth has been to weave it from prepared fibre yarns. The development of plastic sheet in the last ten years or so has brought about dramatic changes in garment making. The extent to which p.v.c. and other plastic sheets are displacing gabardine cloth and rubber impregnated cotton in the manufacture of rainwear and other garments is small at the moment. But the growing demand for these lightweight garments is significant of the "New World" tendency to make attractive goods very cheaply and to scrap them far more quickly than the traditional British "made to last" articles. Whatever may be the ultimate effect of these non-fibrous materials on the world demand for cotton they are of great interest to the electricity supply industry. Many hundreds of radio-frequency electronic welding sets are already in use in this country. Their design and construction exemplify yet another phase in electricity's contribution towards higher productivity.

Apart from the direct electrical demands of the textile industries, there are considerable demands for electricity by the two important ancillary trades, i.e. the makers of textile machinery, and the makers of electric motors and other equipment needed to provide electricity for and drive these machines. It is an unfortunate fact that the very success of the textile machinery makers of this country—and they can rightly claim originally to have taught the whole world how to spin, weave and finish cloth—is one of the major factors in the decline of cotton textile exports from Britain. Such is usually the fate of pioneer countries.

TABLE III

Fibre	Boards mainly concerned	Estimated aggregate max. demand, kW	Annual consumption, million kWh
Cotton (incl. cotton-rayon mixtures) ...	N.W.E.B.	400,000	950
Wool (incl. wool-rayon mixtures)	Y.E.B.	100,000	370
Jute	North of Scotland Hydro-Electric Board	30,000	76
	TOTALS	530,000	1,306

Although the uses of electricity in textile processes have been written about in countless technical papers and other publications in the last 50 years, no single book dealing with the subject has yet been published in this country, if one excepts the most valuable work by Dr. W. Stiel:—"Textile Electrification—A Treatise on the Applications of Electricity in the Textile Industries" written in Germany and published in an English translation in 1933. This deficiency is about to be remedied, and a book entitled "Electricity in the Textile Industries" is in course of publication.

Acknowledgment is due to the North Western Electricity Board, the Yorkshire Electricity Board, and to various manufacturers in the textile and electrical engineering industries for information from which this article has been compiled.

Control Engineering Conference

AN international conference on control engineering took place recently at Heidelberg, sponsored jointly by the German Institution of Engineers (V.D.I.) and the German Institution of Electrical Engineers (V.D.E.). The meeting place was the new buildings of the University of Heidelberg, in which the main hall, which has a seating capacity of about 1,000, was filled each morning by scientists and engineers from eighteen different countries. Parallel sessions were held in the afternoons on more specialised topics, giving the members some choice in the wide variety of papers presented. The standard was very high and the contents were mainly on the theoretical and research aspects of automatic control engineering.

About 80 papers were presented and reprints were distributed many weeks in advance in order to make the preparation of the discussion more adequate. The few weeks' grace was also a great help for those whose knowledge of German was slight and needed time for translation. The bulk of the proceedings took place in German, but Russian speakers were translated concurrently into German. Papers were contributed from Austria (2), France (1), Germany (33), Great Britain (7), Holland (3), Italy (1), Japan (5), Jugoslavia (1), Sweden (3), Switzerland (3), the U.S.A. (13), and the U.S.S.R. (6). Members from Belgium, Czechoslovakia, Denmark, Israel, Norway and Poland also participated in the conference.

The specialised sessions were divided under headings such as regulation techniques, multi-loop control systems, linear methods of analysis, process control, non-linear analysis (which was also the subject of a morning's non-specialised session), hydraulic and pneumatic systems, industrial applications, statistical methods, including some contributions on self-optimising systems and, finally, a session on the use of digital and analogue electronic computers incorporated into automatic control systems.

Industrial visits were also arranged for interested members with transport provided, and the routes were chosen for their beauty and interest to the foreign visitors. The social side was also well organised.

All the lectures and the reports (in full) with the discussions are to be published in a bound volume, which will be available early in 1957. The price to non-conference participants will be about D.M.75 or approximately six guineas, and can be ordered from V.D.I./V.D.E. Fach Gruppe Regelungstechnik, Prinz-Georg Strasse, 77, Dusseldorf.

I.E.E. List of Members

THE Institution of Electrical Engineers has published Part II of its "List of Members," which contains the names and addresses of associates, graduates and students. It is available to non-members of the Institution at 7s 6d. Part I, comprising members, associate members and companies was published in July last year and is now out of print. A new edition will be issued in 1957. In the meantime a supplement to the 1955 issue of Part I, containing additions up to 1st July last, is provided as a loose insert with the present issue of Part II.

Electricity Supply and the Public

THIS subject was chosen for his address by Mr. W. K. Fleming, M.I.E.E., A.M.I.Mech.E., chairman of the North Midland Centre of the Institution of Electrical Engineers. After a brief history of the development of electricity supply in this country, leading up to nationalisation, Mr. Fleming maintained that every member of the community was deeply concerned in the success of the publicly-owned industry.

He proceeded to deal with " public accountability " and the methods in use or in prospect to secure it. The reports of the Select Committees on the subject were touched upon and mention was made of the Government's intention to set up another of these Committees with wider terms of reference.

Mr. Fleming said that the problem of finding the correct balance between Parliamentary supervision and the independence of the Boards was urgent. A satisfactory solution of the difficulty would clearly be a great step forward in the successful development of the public corporation system. He quoted with approval the words of the 1952 Select Committee which recommended the appointment of a committee which " would set up a tradition of conduct which would result in its being regarded by the Board not as an enemy, or a critic but as a confidant, and a protection against irresponsible pressure, as well as a guardian of the public interest."

Following a reference to the value of such investigations as that conducted by the Herbert Committee, Mr. Fleming reviewed the activities of the Consultative Councils. He thought that their usefulness might be increased by giving greater publicity to their work and expanding the activities of their local committees.

He thought that while the achievements and standards of service of the electricity supply industry had done much to secure public confidence there might be scope for better understanding by the public of the work of public corporations. A tendency to criticise public bodies, from the popular conception of bureaucracy, was healthy and criticism could be helpful if it was well-informed. Public criticism should not be resented but met with responsiveness and enterprise. Thus it could be a spur to efficiency and a safeguard for the public.

Public relations must not be merely propaganda or the giving of official explanations. It should be a two-way bridge between the authority and the public by means of which each would better understand the other. Mr. Fleming laid stress on the point that the success of public relations depended very much on the conduct of the individuals employed by the organisation—in their attitudes to their employer and to the public.

The public should be kept fully informed of an authority's plans and policies and the flow of information should also inform, educate and advise them upon the services of electricity to the nation and the individual. Mr. Fleming mentioned the various ways in which information could be conveyed and emphasised the value of " consumer research " to guide authorities in their dealings with the public. He considered that good relations between employees and the public were based on good relations between the management and the employees.

Quoting the late Sir Clifford Paterson, Mr. Fleming said that the electricity supply industry would be judged by its material value, expressed in the way it met the needs of the public with an efficient and economical service of electricity, and its psychological value implicit in the influence it exerted for the public good—the good not only of the public it served, but of the individuals who manned the industry.

INTERNATIONAL FERRITE CONVENTION

THE International Convention on Ferrites which is being organised in London by the Institution of Electrical Engineers (29th October to 2nd November) will have the following scope:—Theory, preparation and properties of ferrites; microwave applications; square loop applications; radio and television applications; and carrier frequency applications.

Some 50 or 60 papers dealing with ferrites and their applications in electrical engineering will be presented and discussed by delegates from France, Germany, Holland, Sweden, U.S.A. and, it is hoped, from Russia, as well as from Britain. An introductory lecture will be given by Dr. Willis Jackson, director of research, Metropolitan-Vickers Electrical Co., Ltd.

A chemical definition of the word ferrite is to be found in the Shorter Oxford English Dictionary, which describes a ferrite as " a combination of ferric oxide with a metallic oxide more basic than itself, as barium ferrite, Ba Fe_2O_4." In the last eight or nine years the term has come to have a particular significance to electrical engineers, as it embraces a new class of useful and artificially-produced magnetic materials. The ferrites in general essentially contain iron and oxygen, and the useful ferrites have deliberate additions of one or more other elements particularly, for example, manganese, nickel or zinc. These compounds have the supreme advantage over ferromagnetic metals and alloys of exceptionally high resistivity. This enables ferrites to be used in the solid form, without laminating or powdering, at the highest frequencies and without the prohibitive eddy-current losses and skin effects which would occur with metals.

The ferrites are hard ceramic substances with a cubic crystalline structure. Crystals of the natural mineral magnetite with the chemical composition Fe_3O_4, which may be written as $FeO\ Fe_2O_3$ have an initial relative magnetic permeability of about 10 and this value may be raised about seven times by purifying the material.

The present applications of ferrites are in the field of communications and in computers. About two-thirds of the papers to be presented to the convention will deal with actual or envisaged applications and with problems arising from them. The materials are of great interest in connection with waveguides and microwave techniques. A considerable part of the time of the convention will be taken up with papers and discussions on microwave applications.

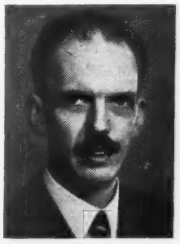
Ferrites may be made to have almost rectangular hysteresis loops. These materials are useful in magnetic memory systems for digital computers and in switching circuits. There are applications also in radio and television receivers and in carrier frequency work. All these subjects will be dealt with.

I.E.E. Provincial Centres

CHAIRMEN FOR THE 1956-57 SESSION

Prof. G. H. Rawcliffe

Mr. H. Robson



Prof. F. M. Bruce

Dr. H. L. Haslegrave

Mr. D. S. Parry

WE have already published the portraits and biographical notes of the chairmen of the Specialised Sections and of some of the Centres of the Institution of Electrical Engineers, and we now give below particulars of the chairmen of the remaining Centres.

Professor G. H. Rawcliffe, M.A., D.Sc. (Western Centre), has been Professor of Electrical Engineering at the University of Bristol since 1944. He was educated at St. Edmund's School, Canterbury, and Keble College, Oxford, obtaining 1st class honours in engineering science in 1932. From 1932 to 1937 he was with the Metropolitan-Vickers Electrical Co., Ltd., first as a college apprentice and later as an electrical machine designer. He was appointed lecturer in electrical engineering at the University of Liverpool in 1937 and in 1941 became head of the Electrical Engineering Department at Robert Gordon's Technical College, Aberdeen, which position he held until taking up his appointment at Bristol. Professor Rawcliffe is the author of a number of papers, mainly on electrical machinery, published in the Proceedings of the I.E.E., the most recent of which, "The Development of a New 3-to-1 Pole-Changing Winding," was awarded a premium in the 1955-56 Session. He has also contributed to the technical and general Press on many aspects of electrical science and practice.

Mr. H. Robson, B.Sc. (Southern Centre), is manager of the Portsmouth District of the Southern Electricity Board. He was educated at Carlisle Grammar School and the University of Manchester, and was a college apprentice with the Metropolitan-Vickers Electrical Co., Ltd. Before nationalisation he held appointments with the Carlisle electricity undertaking, the Brentford and Chiswick electricity undertaking (as deputy borough electrical engineer and manager) and at High Wycombe (as borough electrical engineer and manager).

Professor F. M. Bruce, M.Sc., Ph.D., A.Inst.P., M.Amer.I.E.E. (Scottish Centre), was educated at King's College, Newcastle-on-Tyne, and Queen Mary College, London. From 1935 to 1939 he carried out high-voltage research at King's College for the Electrical Research Association, and was also engaged on installing comprehensive facilities for high-voltage research at the Royal Technical College, Glasgow. From 1946 to 1948 he was in charge of high power testing and research at the Nelson Research Laboratories of the English Electric Co., Ltd., and since 1948 he has been Professor of Electrical Engineering at the Royal Technical College, Glasgow. Professor Bruce was chairman of the North Eastern Students' Section of the I.E.E. for 1938-39, and was chairman of the South West Scotland Sub-Centre in 1953-54. He was awarded the Mather Premium of the Institution for the Session 1946-47.

Mr. H. L. Haslegrave, Wh.Sch., M.A., Ph.D., M.Sc.(Eng.), M.I.Mech.E. (East Midland Centre), is principal of the Loughborough College of Technology. He was educated at Wakefield Grammar School, Bradford Technical College and Cambridge University, and received his training with the English Electric Co., Ltd., with whom he was an electrical machine designer from 1928 to 1931. He subsequently held the positions of lecturer at the Wolverhampton and Staffs Technical College and Bradford Technical College, and (from 1935 to 1938) was head of the Continuation Education Department at Loughborough College. He was principal of St. Helens Technical College from 1938 to 1943, principal of Barnsley Mining and Technical College from 1943 to 1946, and principal of Leicester College of Technology from 1947 to 1953, taking up his present post at Loughborough in 1953.

Mr. D. S. Parry (Northern Ireland Centre) is area manager in Belfast for A. Reyrolle & Co., Ltd. He was educated and trained in London, and from the London University O.T.C. joined the Army, serving during the 1914-18 war in France in the Royal Engineers and the R.F.A. He took up a post-war apprenticeship course with the British Thomson-Houston Co., Ltd., Rugby, following which he held a position in that company's Contracts Department, specialising in switchgear. Later he joined the technical sales staff of Switchgear & Cowans, Ltd., and was for many years in charge of the Sales and Contracts Department of that company.

Future of the I.E.S.

IN our last week's summary of the presidential address to the Illuminating Engineering Society by Dr. W. E. Harper we omitted to include his statement on the future of the Society. Dr. Harper said that there was a temptation which lay close to professional societies of becoming ends in themselves, exclusive and self-satisfied in outlook. Apprehending this danger the Council of the I.E.S. was revising the constitution of the Society to widen its objects and scope. They had to recognise that modern lighting comprehended more than its technicalities and they must set themselves to secure this wider understanding. Such considerations had led the Council to recommend the change of name of the Society to "The Lighting Society" as being more direct, more comprehensive and more appropriate to its duties.

Fuel Efficiency Conference

THE fuel position and possible savings and the question of waste heat recovery were subjects dealt with on 9th October at the Fuel Efficiency Conference, the earlier proceedings of which were reported in the last two issues of the *Electrical Review*. The chair was taken by the president of the Institute of Fuel, Mr. R. H. Gummer, M.I.Mar.E., in the absence of Air Chief Marshal Sir Leslie Hollinghurst.

In presenting a paper on heat and power surveys Mr. L. Clegg, M.B.E., A.M.I.Chem.E., M.Inst.F., said that Britain's fuel requirements and supplies in 1965 would be approximately as follows: home-produced coal, 230 million tons; imported oil (or coal), 65 million tons of coal equivalent; hydro-electric power, three million tons of coal equivalent; atomic energy, six million tons of coal equivalent. It was extremely doubtful whether atomic energy would produce more than 5 per cent of energy requirements by 1965. Greater attention must be paid to fuel efficiency to make the best use of the limited fuel supplies available. Many assumed that large sums had to be spent on new plants before reasonable fuel savings could be achieved. This was not correct.

It was interesting to compare the economics of fuel efficiency with that of other schemes of capital expenditure. The result of installing new plant in power stations since vesting day had been to reduce coal consumption over the period by 17½ million tons from what otherwise would have been required. To achieve this, nearly 7¾ million kW of new plant had been installed at a cost of some £462 million. Last year approximately six million tons more of coal would have been used if the efficiency of generation had remained at the 1948 level. This represented a capital expenditure of £77 per ton of fuel saved. The capital cost on the railways worked out at £43 and on power from nuclear energy £50.

Waste Heat Recovery

Mr. G. N. Critchley, M.Sc., F.Inst.F., dealt with waste heat recovery. The earliest waste heat boilers, he said, came into use over a century ago. Among the industries in which they were now used were the iron and steel, the carbonising and the chemical industries. In the glass industry a waste heat boiler should no longer be regarded as an appendage to, but as a vital and integral part of, a glass-melting furnace. Other equipment which Mr. Critchley discussed included regenerators, recuperators, gas turbines and economisers and superheaters. He urged that economisers should be considered an essential part of a Lancashire boiler plant.

The return on capital invested in well designed fuel-saving equipment was very attractive. Mr. Critchley gave examples where the annual return varied from 70 to 120 per cent and the ultimate return from 12 to 23 times the first cost of the equipment.

Opening the discussion, Mr. G. Nonhebel (I.C.I.) said it was incorrect to state that fuel represented only 2 to 3 per cent of the manufacturing cost. The correct statistic was one in terms of conversion cost of the factory process and was in the nature of 10 per cent. Engineers should provide the individual groups in a factory with an indication of the amount of fuel they were using, and this should be done weekly, while sections making intermittent demands should be shown the peak load cost.

Mr. C. G. Allfrey (Ministry of Supply) wanted superheaters used more as fuel economisers. To-day, labour had become more sensitive to shop temperatures; whereas before the war men would tolerate 45 deg F, now they wanted 60 deg F. Mr. Allfrey described a factory where unit heaters with fans had been replaced by radiant panels, since when there had been no complaints about the heating, and rather less hot water and steam were being used than before.

Mr. H. H. Hellemanns remarked that in Holland managing directors did not appreciate the purpose of work being done on fuel economy.

Mr. W. L. Parkinson (Central Electricity Authority) declared that Mr. Clegg's argument about a capital expenditure for power stations of £77 per ton of fuel saved was fallacious. The C.E.A.'s primary responsibility was to meet the demand for electricity, and as that demand increased it must install more plant. It also sought to save fuel. By the end of 1956 it would have spent £552 million on plant and the amount of coal saved over the whole period would be 23 million tons. Having bought the plant, the Authority had an asset which would go on saving fuel.

Dr. W. A. Macfarlane (N.I.F.E.S.) suggested that there was some confusion from the way the C.E.A. put out its own figures.

Mr. J. N. Waite, C.B.E., chairman of the organising committee of the conference, felt that it did not matter from where the urge for fuel economy came so long as it came. It was the fuel economist's job to persuade management. He had never known a management which, if it found that it could save money, would not do so. Fuel efficiency resolved itself into a ceaseless watch on a host of essential details.

Mr. R. H. Chilton, consulting engineer, thought that the fringe of fuel saving had hardly yet been touched.

Mr. E. J. Macdonald (James Hodgkinson (Salford), Ltd.) thought that the great advantage of an economiser was that it made a Lancashire boiler insensitive to bad firing.

The chairman said that there could be no better example than the advancement made by the Central Electricity Authority in the matter of capacity. After the war they installed 360 klb/hr of boiler plant. These were 100 per cent efficient but the capacity had been increased on new installations until they were now having boilers with 200 MW capacity (equivalent to 1,600 klb/hr), and they expected to go forward to boilers with 300 MW capacity.

Teleprinter Demonstration at I.E.E. Meeting

DURING the meeting of the Tees-Side sub-centre of the Institution of Electrical Engineers on 3rd October a practical demonstration of the potentialities of teleprinting was given by the incoming chairman, Mr. F. V. Allan, chief engineer of the Middlesbrough G.P.O. district. He sent out two messages on a specially installed teleprinter in the meeting hall, one to Sir Gordon Radley, president, I.E.E., in London, and one to the vice-president of the Radio Corporation of America, New York. Suitable replies were also received at the meeting, the U.S.A. response beating that from London by a few minutes.

Mr. Allan said that Middlesbrough's super-modern telephone exchange would be ready to receive underground cables next July, and it would provide much more direct dialling of trunk calls. Operators would have "desk like" comfort, with keys instead of flexible connections between lines. Calls would automatically be dealt with in the order in which they arrived at the exchange.

Sound Broadcasting and Television

Sir Harold Bishop's Presidential Address to the A.S.E.E.

THIS year's presidential address to the Association of Supervising Electrical Engineers was delivered by Sir Harold Bishop (British Broadcasting Corporation) on 16th October. Before dealing with his main subject of engineering developments in sound broadcasting and television, Sir Harold discussed the status of technicians in relation to that of chartered electrical engineers. In most electrical organisations, he said, technicians should be five to ten times the number of the latter, but could rise to positions of equal technical responsibility in some cases. To some members of the A.S.E.E. the title "technicians" was inacceptable as seeming to be slightly derogatory, but he considered that view mistaken. In contacts with the Press and public there would be great advantage in the adoption of a single title for all members of the Association. The electrical technician's certificate of the City and Guilds of London Institute was endorsed by the I.E.E., while the full technological certificate was also endorsed by the Ministry of Education. These courses could logically be developed to meet the requirements of a broader-based membership of the Association.

Provision of Frequency Channels

After outlining the history and organisation of the B.B.C., Sir Harold discussed the increasing difficulty of providing enough frequency channels that were free from interference in the low and medium bands (150 to 285 kc/s and 525 to 1,605 kc/s) used for domestic broadcasting here and abroad. Since the most recent allocation of frequencies in Europe took place in Copenhagen in 1948 the number of stations and synchronised groups had increased from 243 to 400 and the additional ones had forced themselves into the existing bands.

Because the number of low and medium frequencies allocated to the United Kingdom was insufficient for national coverage of the three sound programmes and because of a steady increase in interference from transmitters in Europe, the quality of reception had deteriorated. The B.B.C. therefore had proposed the construction of transmitting stations in the very-high-frequency band (87·5 to 100 Mc/s) to reinforce the existing systems. At present, however, many millions of sets were in use which could not receive v.h.f. For long-distance broadcasting in the high frequency bands the position was even worse.

The percentages of the population of the United Kingdom which enjoyed interference-free reception of the three programmes fell sharply after dark, the figures now being: Home Service, 85 to 90; Light Programme, 90 to 95; Third Programme, 60 to 65. Defects could not be eliminated by increasing the power, as this also increased the waves reflected from the ionosphere.

The major advantage of v.h.f. was freedom from distortion due to these reflected waves and interference from some domestic appliances. Its disadvantages included a rapid decrease in signal strength with distance from the transmitter and a liability to be affected by the nature of the intervening ground. By the end of 1956 nine three-transmitter stations using frequency modulation would be serving over 80 per cent of the population and two years later seven more, raising the percentage to over 95. More than half a million receivers of appropriate design were already in the hands of the public. Of the 14 million licences, six million were for sound and television and eight million for sound only. The number of combined licences in recent years had increased by about one million a year.

The first regular television service in the world was transmitted from the Alexandra Palace in 1936 with 405 lines, 50 frames, interlaced, as against the 625 lines, 50 frames, standard in Europe. The B.B.C. now had fourteen television stations serving 95 per cent of the population, which would be increased to 98 per cent next year by the addition of four others. Its aim was to provide an alternative service, which would, probably, be developed on the same lines, i.e. by installing additional high-power transmitters at the existing stations to cover the main centres of population and lower-power transmitters at the other stations to fill in the gaps.

Permanent cable and radio links, rented from the Post Office, connected all stations and had recently been extended to the Continent, entailing conversion between 405 and 625 lines. Each large studio (ten in London and one in each main regional centre) cost about £200,000 for building and equipment. In addition to electronic appliances it would have approximately 250 kW of lighting and control apparatus. To record a television picture on magnetic tape the bandwidth would have to be 300 times as great as in sound broadcasting. Nevertheless, the B.B.C. hoped to have in use experimental equipment of this type. Colour television could be achieved by transmitting three simultaneous pictures in red, blue and green and combining them at the receiving end, but such a system would require three times the bandwidth used for a monochrome picture, which was the maximum permissible. Experimental transmissions were now being made with a view to reception of colour pictures by ordinary monochrome receivers from one transmitter only.

Commonwealth Welding Conference

WE have now received from the Institute of Welding a list of 50 or so papers which are to be presented at the British Commonwealth Welding Conference in London and Saltburn-by-Sea from 17th to 29th June, 1957. Some of the listed papers, selected because they seem to us to involve electric welding in particular, are as follows:—

"Welding in Boilers and Power Station Plant," by Mr. T. Carlile and Dr. H. Harris (Babcock & Wilcox, Ltd.); "Welding in Locomotive and Carriage and Wagon Workshops of British Railways," by Mr. G. Foster (L.M. Region, British Railways); "The Welding of Aluminium in the Chemical and Allied Industries," by Mr. W. A. Gardner (Aluminium Laboratories, Ltd.) and Mr. T. J. Peake (Northern Aluminium Co., Ltd.); "Welding and the Industrial Application of Atomic Energy," by Mr. L. Rotherham and Mr. I. H. Hogg (United Kingdom Atomic Energy Authority (I.G.)); "Automatic Arc Welding as a Production Tool," by Mr. J. A. Lucey and Mr. A. H. B. Swan (Quasi-Arc Co.); "Precision Resistance Welding for Greater Productivity in Quantity Production," by Mr. E. V. Beatson (Joseph Lucas, Ltd.); "Recent Developments in Inert Gas Welding of Aluminium," by Messrs. J. A. Hirschfield, H. L. Saunders and M. J. Waite (Aluminium Laboratories, Ltd., Canada); and "Some Notes on Applications of Ferrite Controlled Electrodes," by Mr. M. C. T. Bystram (Murex Welding Processes, Ltd.).

Scientific Instruments

S.I.M.A. ANNUAL CONVENTION AND INSTRUMENT DISPLAY

THE fifth annual convention of the Scientific Instrument Manufacturers' Association, which was held at Eastbourne from 11th to 14th October, had as its theme " Production, 1947." Technical sessions were opened on Friday morning by the president, Mr. G. A. Whipple (Hilger & Watts), who introduced the guest speaker Mr. S. J. Hurley (Coventry Gauge & Tool Co.). Thereafter the delegates separated in four panels meeting simultaneously, each of which held four sessions including a final open forum on the following morning.

The first panel (Production 1) under the chairmanship of Mr. F. Wickstead (Rank Precision Industries) dealt with optical and mechanical matters and the second (Production 2), with Mr. P. Gordime (Electronic Instruments) in the chair, was concerned with electrical and electronic aspects. The two other panels, Research and Marketing, had as chairmen Sir Bernard Keen (Baird & Tatlock) and Mr. A. E. Evans (Evans Electroselenium), respectively.

In the opening session of Production 2, Mr. K. Kandiah (Electronics Division, A.E.R.E., Harwell) analysed the aims of production testing with especial reference to certain types of equipment. He then considered failures in electronic apparatus which were related to production testing and discussed their significance in application. Failures at A.E.R.E. during the past few years indicated the most important items requiring attention in order to improve reliability. Printed circuits provided the subject of the second session, which was introduced by Mr. A. D. Clouter (Technograph Printed Circuits) with a brief reference to printing and etching methods, followed by descriptions of materials used, including those for flexible bases and resistive foils, and of finishes in solder coating, electroplating and lacquering. Some particulars of costs of producing and using printed circuits and of their maintenance were given and their advantages and disadvantages were summarised.

At the third session of Production 2, Mr. G. Grimsdell (Mullard) suggested that transistors must show definite advantages before they would take their place beside magnetic amplifiers, radio valves and other power amplifying devices. Among the advantages of transistors in application were small size, need for low-voltage supplies, low current consumption, negligible microphony, ability to operate without warming-up time, absence of heater hum and long life. Their limitations differed considerably from those of valves and must be closely known before circuit designs could be produced that were suitable for incorporation in equipment produced in quantity. In manufacture the small size and solder-in properties of transistors enabled them to be used in printed circuit techniques and automatic assembly, while their low heat dissipation facilitated encapsulation and plotting of complete circuits.

Display in London

The third instrument display, organised by the Association, was recently opened at Sima House, 20, Queen Anne Street, London, W.1. This latest display shows a further cross-section of the British instrument industry and will remain open until the end of the current year. The exhibition will allow some interchange of equipment by members during this period.

In the nucleonics and electronics section, Ekco Electronics, Ltd., are showing a high-resistance measuring set designed for the accurate measurement of the high values of resistance and insulation encountered in nucleonic equipment. Its range is from 10^6-10^{14} ohms.

Electronic Instruments, Ltd., have on view a chronotron millisecond meter, which is capable of measuring to thousandths of a second. It is an electronic stop clock which is used to measure speeds of projectiles, rockets, aircraft, etc.

The Fielden proximity meter has a sensitivity which is far greater than can be practically employed and the limits are invariably imposed by the physical stability of the measuring arrangement to which it is applied. A movement of less than 0·000001in may be detected in the field of mechanical displacement with a suitable electrode arrangement. The Solartron Group, Ltd., have on display an oscillator and a solarscope. Ericsson Telephones, Ltd., are showing their add-on counting equipment which gives direct readings of the r.p.m. of a small motor whose speed can be varied.

Various photo-cell devices are featured by Evans Electroselenium, Ltd. For instance, the reflectance spectrophotometer is used in the routine estimation of the colour of any flat surface, and its accessory, the gloss head, is used for high gloss measurements on flat surfaces. The reflectometer has been designed for absolute measurements of percentage reflectance of surfaces, and the opacimeter provides an accurate measure of the percentage printing opacity of papers. Fleming Radio Developments, Ltd., have on view a single pulse and fast multiple pulse generators, as well as a logarithmic ratemeter. Wane Kerr Laboratories, Ltd., are showing various test equipments—inductance meters, component bridges and a video oscillator.

Nash & Thompson, Ltd., exhibit further examples of their organic crystalline and plastic phosphors, whilst Marconi Instruments, Ltd., have their portable pH meter, their moisture meter for determining moisture in grain, etc., and other items of test equipment such as their universal bridge. Hendrey Relays, Ltd., have a selection of their switches and relays on view, together with a vibration table.

Cass & Phillip, Ltd., are exhibiting various timing devices, including elapsed time indicators, and a wavemeter and u.h.f. coaxial switch are also to be seen.

In the laboratory section, Baird & Tatlock, Ltd., show the Van Slyke standard manometric gas analysis apparatus which is used mainly for the determination of carbon dioxide in blood, carbon monoxide in blood and plasma and similar determinations. The sedimentometer of Griffin & George, Ltd., is used for particle size determination and has many applications.

In the optical section, Hilger & Watts, Ltd., display their absorptiometer and fluorimeter, which may be seen working with test samples.

W. F. Stanley & Co., Ltd., have contributed their micrometer theodolite and planimeter which have wide applications in surveying.

Measuring microscopes, auto-collimators, spectrometers and cathetometers are displayed by the Precision Tool & Instrument Co., Ltd., and the British American Optical Co., Ltd., have a show of their diamond impregnated metal bonded tools.

NEW ELECTRICAL EQUIPMENT

Car Battery

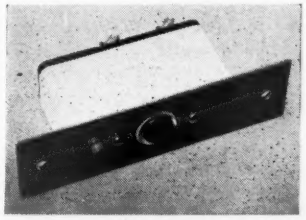
The "Golden Crompton" car battery now being marketed by CROMPTON PARKINSON, LTD., Crompton House, Aldwych, London, W.C.2, has a factory-sealed charge. Briefly, this feature means that motorists are assured of receiving an absolutely fresh battery when they need a replacement and that garages can have a new battery ready for use in as little as thirty minutes.

The plates in the "Golden Crompton" battery go through a special process. In the finished battery power is released for use as soon as the electrolyte has soaked into the plates. This soaking has progressed sufficiently far by the end of half-an-hour to enable the battery to be put into immediate use.

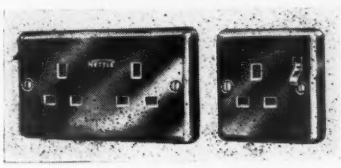
Miniature Circuit-Breaker

A circuit-breaker which measures only $2\frac{7}{16}$in by $1\frac{1}{4}$in by $\frac{3}{4}$in is available from the BRITISH CENTRAL ELECTRICAL CO., LTD., 6 & 8, Rosebery Avenue, London, E.C.1. The action is positive and accurate to within 0·1 A. Units are available with a trip button to enable the circuit to be opened under normal conditions; the unit cannot, however, be prevented from tripping by an irresponsible workman attempting to hold the breaker in, and once tripped, it cannot be reset until the fault is corrected. Resetting is manual and immediate.

The units are of robust, simple construction in non-inflammable moulded cases, and can be supplied with flat screw contacts. They are suitable for mounting on steel plates up to 8 s.w.g. thick, but an alternative is available fixed to a polished aluminium plate, for mounting on a case or cover of any thickness. Each type is available with or without manual trip button. The range made is from 0·1 A to 22 A in 0·1 A steps (suitable for 400 V a.c. or 150 V d.c.).



British Central miniature circuit-breaker



Nettle 13 A socket outlets

Socket Outlets

The range of 13 A accessories made by NETTLE ACCESSORIES, LTD., Harper Road, Wythenshawe, Manchester, 22, has been extended by the introduction of a semi-sunk 13 A switch socket which can be used in conjunction with the standard plaster depth lug fixing switch box to B.S. 1299 centres. This new accessory incorporates all the established features of the company's 13 A range. Nylon shutters are fitted as standard, all terminal fixing screws are easily accessible from the top and the plate of the china base has been kept as small as possible to give the maximum wiring space.

This company has also redesigned its 13 A semi-sunk twin gang unit. All terminal screws are now accessible from the top of the plate and a common earth pillar is provided, earthing both of the fixing screws.

Portable Frequency Meter

A new design of frequency meter giving direct readings of frequency from 15 c/s to 100 kc/s in six switched ranges has been developed by the BRITISH THOMSON-HOUSTON CO., LTD., Rugby. The instrument incorporates junction transistors and germanium diodes, and the frequency under test is shown on the linear scale of a moving coil instrument. Accuracy is of a high order and is independent of input waveform within a wide range of applied volts. It is mains operated and weighs only 9 lb.

Basically the instrument consists of a saturating transistor amplifier which charges and discharges a capacitor on each cycle of the input voltage. As the mean current through the capacitor is proportional to the input frequency, it can be rectified and shown directly in terms of c/s on the scale of a d.c. moving coil meter.

Provision is made on a rotary switch for selecting any one of six frequency ranges with full-scale deflections of 300 c/s; 1 kc/s; 10 kc/s; 30 kc/s; or 100 kc/s, respectively. On all but the highest range the accuracy of measurement is better than 1 per cent of full-scale deflection; even on the highest range this accuracy holds good up to about 70 kc/s, but because of limiting transistor characteristics, measurements above this frequency may be subject to greater inaccuracy, but not more than 5 per cent at 100 kc/s.

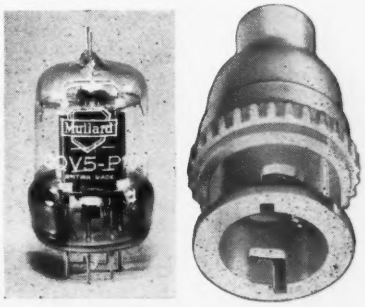
To maintain the inherent accuracy of the equipment over a wide input voltage range, another switch is provided to select one of two appropriate inputs to the amplifier to suit the applied voltage. As a result, the instrument can be used to measure frequencies within the accuracies mentioned above with inputs ranging from 0·1 V to 500 V. The instrument is essentially a current-operated device and takes 40 μA r.m.s. for a sine-wave input and up to 110 μA peak-to-peak for other waveforms.

Pulse Modulator Valve

A new double tetrode valve, the QQV5 P10, for use in the pulse modulators of radar and radio equipment, is offered by MULLARD, LTD., Century House, Shaftesbury Avenue, London, W.C.2. It is capable of delivering pulses of 5 kV, 10 A when both sections are connected in parallel. The valve is suitable for pulse durations up to 3 μsec and duty factors of 0·001. The anode dissipation is 15 W maximum and under typical conditions the total power input to the stage is 85 W.

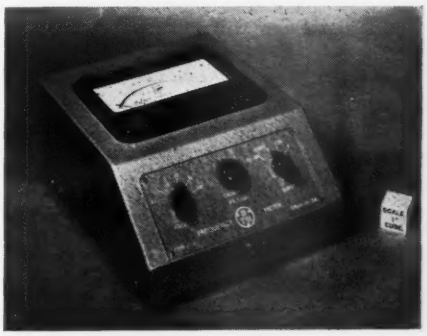
Nylon Lampholders

A range of all-insulated nylon lampholders is offered by the BRITISH CENTRAL ELECTRICAL CO., LTD., 6 & 8, Rosebery Avenue, London, E.C.1. They are moulded entirely in nylon and no porcelain or other breakable materials are used. Lampholders are ivory in colour, of pleasing appearance; the colour does not change with age. The contacts are brass and made without current carrying springs, thus being suitable for l.v. duty. A



Left: Mullard double tetrode pulse modulator and (right) British Central nylon lampholder

B.T.H. type JT2 frequency meter

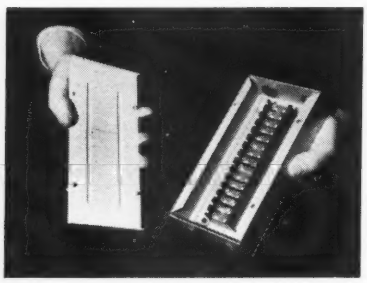


further feature is a positive cable grip which prevents strain on the conductors. These lampholders are available with a cord grip, or threaded ½in brass, ⅜in and ¾in conduit thread.

Junction Boxes

A range of light current junction boxes, designed to conform with the various sizes of paired cables common in the telephone and associated light current industries, has been introduced by COMMUNICATION SYSTEMS, LTD., Strowger House, 8, Arundel Street, London, W.C.2. Although primarily intended for use in telephone, public address, and signalling systems, the boxes have many other applications.

Compact in design, they are finished in a hard durable grey enamel, and sufficient room is allowed for the easy



Communication Systems light current junction box

arrangement of cables when formed and laced in accordance with normal telephone practice. Ample entries, fitted with rubber grommets, are provided so that cables can be run out from either end, and designation labels printed on the inside of the lids enable particulars of the lines connected to be clearly marked. Five sizes are being manufactured: 15, 30, 45, 52 and 78-way, the dimensions ranging from 8in by 4in by 1⅞in deep to 20in by 8in by 1⅞in deep.

Portable Operating Poles

For some time now, LINE EQUIPMENT, LTD., 32, Queen Victoria Street, London, E.C.4, have been supplying a limited number of portable operating poles made from resinated glass fabric tubing. As these have proved most satisfactory the company has decided to standardise on the use of "Fibreglass" and will no longer supply silver spruce wood operating poles, except where these are required as replacements.

With the use of this material, metallic joints between sections are avoided, and the operating poles are extremely light (less than half the weight of a wood pole); one 4ft section weighs 1 lb and a complete 16ft four-section operating pole weighs only 4¼ lb excluding the pole head. The electrical characteristics are so good that the standard operating pole should be suitable for all voltages, without the provision of additional porcelain insulation.

"Fibreglass" has negligible moisture absorption, is unaffected by salt water and resistant to chemical action. Dimensional stability is similar to that of mild steel and tensile strength is about 20,000 lb/sq in; its coefficient of expansion is very low. All intermediate sections are interchangeable and adaptor pole heads previously supplied can be used with these new operating poles.

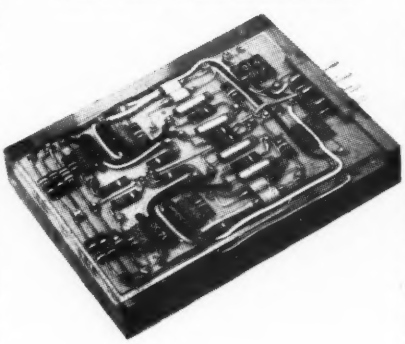
Polyphase Meters

Two new single disc type polyphase meters have been introduced by FERRANTI, LTD., Hollinwood, Lancs. These meters are known as the FMmX and can be in all-insulated form; they incorporate the same element as the type FMm single-phase meter. The driving elements are mounted on a box type diecast frame to give rigidity and protection against distortion from line surges and other mechanical shocks. The brake magnets are of the anisotropic pattern, and are completely enclosed in diecastings. The registering mechanisms are of the pointer type constructed of light alloys. No lubrication is required, since the friction level is so low, well below that of the older brass wheel and steel staff type of registering mechanism.

Particular attention has been paid to ease of calibration. With the exception of the main load adjustment, which is operated from the front, all the adjustments are accessible from the top. Thus, it is easy to calibrate meters when they are mounted close together on a test bench. All the adjustments are of the micrometer pattern with locking screws, and no sliding contacts are used. The error/load curve is exceptionally straight up to 25 per cent overload, as the meters are fitted with overload compensation. Moreover, both temperature and voltage compensation are incorporated ensuring good performance over all conditions of temperature and voltage variation likely to arise in service. The meters comply with British Standard 37, Part 4, 1954, and have been submitted to the Ministry of Fuel and Power for approval.

Ferranti type FMmX polyphase meter

Venner decade unit encapsulated in clear resin to show the internal construction



Capless Flashbulbs

The A.E.I. LAMP & LIGHTING CO., LTD., Crown House, Aldwych, London, W.C.2, announces the introduction of a new capless flashbulb, the "Mazda" No. 5. It is a wire filled clear lacquered bulb of the Class M type, with a glass base integral with the envelope instead of the conventional brass cap. An adaptor is available enabling it to be used with any flashgun with an ASCC socket. Peak time for the new bulb is about 20 millisec and the total light output is 18,000 lumen-sec; the flash duration at half peak is 12 millisec. The "Mazda" No. 5 will be available from 15th October, price 1s.

Decade Counter and Scaler

A transistor decade counter and scaler has been developed by VENNER ELECTRONICS, LTD., Kingston By-Pass, New Malden, Surrey, to meet the demand for a small and compact device having a low consumption which can be used either as a stable divide-by-ten stage or, in conjunction with a meter, as a counting stage. The unit employs transistors and germanium diodes throughout, arranged in four Eccles-Jordan stages with feed back; it will count or divide from zero up to 30 kc/s. Only a 10 V power supply is required, the total consumption being 100 mW as a scaler and 160 mW as a counter.

The construction is interesting in that 86 components, including 8 diodes and 8 transistors, are assembled on a double sided tagboard size 4in by 3in. This is then encapsulated in epoxy resin to form a block size 4½in by 3¼in by ¾in, which in turn is fitted with an eight-pin plug so that the unit is ready for direct insertion into equipment.

One decade may be directly connected to another, with no additional components, and thus by using four in cascade fed from a transistorised 10 kc/s crystal oscillator (also made by the company) an output pulse every second may be obtained. Alternatively, by connecting a meter to each stage and again feeding the decades from the crystal oscillator but having a switch (or contacts) to interrupt the flow of pulses from the crystal oscillator, a short period timer is obtained which indicates directly on the meters (to the nearest 0·1 millisec) the time for which the switch (or contacts) have been closed.

GENERATION AND DEVELOPMENT

Tenders for Scottish Nuclear Station

The South of Scotland Electricity Board expects to receive tenders on 1st November for the nuclear power station which it proposes to build on the Ayrshire coast. Mr. J. S. Pickles, chairman of the Board, made this announcement at a ceremony in Invergarry, Inverness-shire, to mark the commissioning of the Garry hydro-electric scheme by the North of Scotland Hydro-Electric Board. The nuclear scheme, he said, would go into operation in the winter of 1961. Hunterston, between Seamill and Fairlie, is suggested as the site for the station, the installation at which would consist of two reactors and generating plant with a total capacity of 250-300 MW.

Higher Efficiency in the South West

Mr. A. N. Irens, chairman of the South Western Electricity Board, speaking at a meeting of the Consultative Council in Exeter last Friday, said that the South Western Division of the Central Electricity Authority had achieved the highest availability of plant in the whole country during the last winter's peak period. Ability to maintain supplies in the South West, in spite of reduced imports of energy was due largely to the South Western Generating Division's success in keeping 99 per cent of plant going continuously. Turning to distribution, he said that by providing more sub-stations in the South West for feeding supplies from the main 33 kV "backbone" into the distribution networks, the Board had helped to achieve a higher rate of distribution efficiency within the Area than in any previous year.

Water Power in Ulster

In his presidential address to the Belfast Association of Engineers, Mr. T. G. Christie, chief engineer of the Electricity Board for Northern Ireland, referred to the Bann and Mourne hydro-electric schemes as "potentially the most important of the few natural resources of Northern Ireland by way of power production." It was the considered view of the Joint Committee, the Electricity Board and their consultants, he said, that steps should be taken to proceed with the two developments as a matter of urgency in the national interest. Even when full weight had been given to all the objections referred to in the White Paper, during the Bann inquiry and elsewhere, neither financial loss nor any serious degree of personal hardship need be occasioned to any of the objectors under the proposals for the development of these natural sources of power.

Based on the carefully considered and conservative estimates by the consulting engineers, the combined Bann and Mourne schemes were assessed as capable of producing annually on the average 127·5 million kWh at 0·617d/kWh. This would save the import of 75,000 tons of coal per annum, costing £352,500 at 94s per ton. The saving in cost of production by water power as against coal-fired generation was estimated at £190,746 per annum. Pointing out the employment benefit of the schemes, Mr. Christie said that during peak construction periods there would be a total labour requirement of 1,625, most of it unskilled.

For the year 1960-61 the system load of Northern Ireland as a whole was estimated at 503 MW and with work now in hand on extensions at Belfast Power Station West, the installed capacity would be 551 MW. A margin of only 48 MW would thus be left to meet the contingency of a single 60 MW set being out of commission during peak load periods. It was therefore essential that additional plant should be installed and ready to take the load at that time. The proposed water power stations on the Bann and Mourne would have been most effective in satisfying the present conditions and those which might arise as the first step in meeting the deficiency in plant from 1960-61 onwards.

Advantages of Proposed Victoria Tube

Speaking to members of the North East London Branch of the Institute of Industrial Administration at Walthamstow on Monday, Sir John Elliot, chairman of London Transport, said that road traffic congestion was having a strangling effect on the life of London. The proposed Victoria tube line (Walthamstow to Victoria) would provide a very important relief to this congestion, diverting traffic which at present used London Transport's road services and, more important, would encourage people to leave their cars at home and not use London's road space so extravagantly. It was estimated that if the line were built, London Transport would be able to reduce by nearly 10 per cent the number of buses running along the western half of Piccadilly each week-day and by nearly 20 per cent the number of trolley-buses in the Seven Sisters Road.

"We believe," said Sir John, "that the Victoria Line is justified both on traffic and social grounds, and we feel confident that it will one day be built; but we must face facts; how is it to be paid for?" There was no doubt that when constructed the line would pull its weight with the other Underground lines and that loadings would be good.

The Victoria Line would cost about £51 million, resulting in a net loss to London Transport of £¼ million a year, which would be increased by interest charges to about £2¾ million a year. If they did not build the Victoria Line, however, they or their successors would be forced into considerable expenditure in order to provide a much smaller measure of relief to congestion, which would only touch on the fringes of the problem. The question of financing the scheme was under review with the British Transport Commission at the present time.

Street Lighting

LEICESTER City Council proposes to spend £20,000 on the conversion of further gas side street lighting to electricity.

Practically the whole of YEOVIL will have been converted from gas to electric street lighting when a new £24,525 scheme, which awaits Ministry sanction for loan raising, is carried out.

OVERSEAS

Kariba Contracts

Sir Malcolm Barrow, Rhodesian Federal Minister for Power, announced last week that 98 per cent of the mechanical and electrical equipment contracts for the £80 million Kariba hydro-electric project had gone to British firms. Addressing members of the British Electrical and Allied Manufacturers' Association, Sir Malcolm said this was proof that Rhodesia still believed in supporting the Mother Country whenever possible.

The Italian firm which had been awarded the main contract for transmission lines had spent £4 million with British sub-contractors. Except for one contract worth £100,000, all orders for mechanical and electrical equipment, to the value of £7·5 million, had gone to British manufacturers who had "all but swept the board" in contracts for the supply of material and machinery for the generation and transmission side of the Kariba project.—*Reuter* (Salisbury).

Australian Plant Capacity

The total installed generating plant capacity in Australia increased by some 356,000 kW to approximately 3,470,000 kW during the financial year ended 30th June, 1955, it is now officially announced. In New South Wales, Queensland, South Australia and Western Australia the increased capacity was sufficient to meet demand without restriction, but there was a small deficiency in Victoria and Tasmania. The principal means of bridging the gap in N.S.W. was the placing of orders in the United States for 16 "packaged" 5,000 kW steam generating units capable of burning either coal or furnace fuel.

Financial Section

STOCKS and SHARES

INDUSTRIAL markets of the Stock Exchange have continued to be subdued by a trio of main factors consisting of the Middle East problems, the signs of contraction in company profit margins, and an outcrop of new issues. While the first of these is common to all the market, the other two seem to have impinged in particular upon the electrical equipment and engineering sections. On the subject of profit margins, the A.E.I. half-yearly report has made a persistent impression. In the new issue field, the G.E.C. operation now in progress to raise £14½ million is thought quite likely to be followed before long by capital proposals from one or two of the other big electrical groups. Dealings began this week in Automatic Telephone & Electric new £1 ordinary shares, offered to existing shareholders, on a one-for-three basis, at 46s. They opened at a premium of around 6s 6d.

Price Changes

The dullness affecting shares in the big electrical engineering groups was noticeable particularly in the further fall of Reyrolle ordinary, which lost 7s 6d over the week to 97s 6d; the price started this month at 111s 3d. Parsons were steadier at 86s 3d but English Electric and A.E.I. were both easier. In the heavy engineering group, Babcock & Wilcox and Clarke Chapman were each half-a-crown lower. I.C.I. changed hands below 40s for the first time this year, but recovered to just over that figure. Declines of up to 1s or so were distributed fairly plentifully down the list. A bright exception to the trend was the rise of 1s 3d, to 7s 3d, in Dictograph Telephones; the company's final dividend was declared last time early in November. Thorn Electric also put up good resistance, and Broxlea Holdings have been active at around 3s.

Merger Proposals

Veritys 5s shares were changing hands in the market at around 9s 4½d, and Limit Engineering 1s shares at 2s 7½d, pending further advices to Veritys' shareholders regarding the merger proposal. This takes the shape at present of an offer to exchange each Veritys for four Limit Engineering shares. The Veritys board are agreed upon the desirability of the merger but, not being unanimous on the acceptability of the terms offered, they are seeking independent advice on this point and promise another statement soon. In connection with another merger proposal, the directors of Associated Insulation Products are accepting, in respect of their own holdings, the share-for-share exchange offered by Elliott Brothers, and advise other shareholders to do the same. The prices of the two shares have come nearer together at 26s 6d for A.I.P. and 27s 6d for Elliott Brothers. A.I.P. has some £800,000 funds which are largely surplus to its own requirements, and sees opportunities for employing them profitably, through the merger, in the fields of automation and

Price Changes in

Company or Board	Nom. Value	Middle price 15th Oct.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	74½		3	3	4 0 6	80½	73½
Brit. Elec. 1974/77	100	72½		3	3	4 2 9	79⅛	71½
Brit. Elec. 1976/79	100	76⅜x.d.		3½	3½	4 11 6	84	76½
Brit. Elec. 1974/79	100	86½		4½	4½	4 18 3	95	86½
Overseas Electric Supply								
Calcutta Elec.	£1	19/3		6†	6†	6 4 9†	20/9	19/-
East African Power	£1	20/-	+6d	7	7	7 0 0	21/3	19/6
Nigerian Elec.	£1	17/6		10	10*	11 8 6	21/-	17/-
Perak Hydro-Elec.	£1	17/-		10	10*	11 15 3	17/6	14/9
Equipment and Manufacturing								
Aberdare Cables	5/-	12/-		17½	17½	7 5 9	13/6	10/6
Aerialite	1/-	5/3		88⅛	45*	8 11 6	6/9	4/9
Allen, W. H.	£1	38/9		20	10*	5 3 3	39/-	33/6
Aron Elec. Ord.	£1	55/6		15	15	5 8 0	56/-	53/6
Assd. Automation	10/-	17/6	−6d	10	5	2 17 3	19/-	17/-
Assoc. Elec. Ord.	£1	62/6	−1/3	14	15	4 16 0	85/6	57/9
Automatic Tel. & El.	£1	53/9x.r.		15	15	5 11 6	72/6	56/3
Babcock & Wilcox	£1	73/3	−2/6	15	15	4 2 0	85/6	64/-
Baldwin, H. J.	2/-	5/-		20	20	8 0 0	5/-	3/9
Bakelite	10/-	26/-		16	16	6 3 0	34/-	26/-
Berry's Electric	5/-	6/-		—	10‡	8 6 9	6/6	5/9
British Aluminium	£1	65/6	−2/-	12	12	3 13 3	78/9	40/6
B.I. Callender's	£1	48/9	−6d	10	12½	5 2 6	54/3	45/-
B.I. Callender's 6% Pref.	£1	21/9		6	6	5 10 3	22/6	20/3
British Tabulating	£1	48/-	−9d	9	9	3 15 0	51/3	37/3
British Thermostat	5/-	26/3		20	25	4 15 3	31/9	24/6
British Vac. Cleaner	5/-	7/9	−3d	30	15*	9 13 6	8/9	6/-
Brook Motors	10/-	35/-		20	25	7 2 9	44/-	31/9
Brush Group	5/-	6/-		10	10	8 6 9	7/9	5/9
Bulgin, A. F.	1/-	4/9		45	50	—	5/3	4/3
Burco Dean	5/-	9/-	+6d	—	22½	12 10 0	13/6	8/3
Chloride El. Storage "A"	£1	62/-	−1/-	17½	17½	5 13 0	73/6	60/9
Clarke Chapman	£1	116/3	−2/6	20	22½	3 17 6	123/-	89/6
Cole, E. K.	5/-	16/3	−6d	17½	17½	5 7 9	22/3	15/6
Cossor, A. C.	5/-	6/-		15	Nil	Nil	10/3	5/-
Crabtree	10/-	24/-	−6d	20	20	8 6 9	29/3	24/-
Crompton Parkinson Ord.	5/-	13/-	−3d	20	16*	6 3 0	15/-	12/3
De La Rue	5/-	16/3	−3d	30	30	9 4 6	20/3	15/-
Decca "A"	4/-	26/3		56½	43¾*	6 13 3	44/9	24/9
Desoutter	5/-	31/-		25	30	4 16 9	32/9	25/9
Dewhurst	2/-	5/6	−6d	24	30	—	7/6	5/3
Dictograph Tel.	2/-	7/3	+1/3	20	20	5 10 3	6/9	5/6
Dubilier Condenser	1/-	5/-	+6d	25	30	6 0 0	4/9	3/6
Duport	5/-	18/9		23	25‡	6 13 3	21/6	13/9
E.M.I.	10/-	26/3	−1/-	10	15	5 14 3	37/-	25/6
Electrical Components	5/-	15/-		25	25	8 6 9	16/-	12/6
Elec. Construction	£1	23/9		8½	8½	7 2 3	29/9	23/9
Elliott Bros.	5/-	27/6	−1/3	19	17½*	3 3 9	36/9	24/6
Enfield Cable Ord.	£1	15/-		Nil	Nil	Nil	19/3	13/6
English Electric	£1	45/-	−1/3	12½	12½	5 11 0	66/3	46/3
English Electric 3¾% Pref.	£1	13/-		3¾	3¾	5 15 6	14/6	12/6
Ericsson Tel.	5/-	37/6	−6d	20†	20†	2 13 3†	42/9	33/6
Ever Ready	5/-	28/3	−6d	35	35	6 4 0	32/9	24/-
Falk Stadelmann	£1	36/3	−6d	15	17½	9 13 0	45/9	36/9
G.E.C. Ord.	£1	42/6	−1/3	12½	14	6 11 9	65/6	42/6
G.E.C. 6½% Pref.	£1	22/-		6½	6½	5 18 3	23/9	21/3
General Cables	5/-	12/3		30	30	12 5 0	13/9	11/3
Greenwood & Batley	£1	46/3		17½	17½	7 11 3	47/6	45/-
Hackbridge Holdings	5/-	22/3		25	30	6 14 9	24/6	18/9
Hackbridge & Hewittic	5/-	17/6		30	23*	6 11 6	22/-	17/3
Heatrae	2/-	3/9		15	15	8 0 0	5/1	3/9
Henley's	10/-	15/3	−1/-	10½	11½	7 10 9	19/9	14/-
Holophane	5/-	21/-	−3d	30	30	7 2 9	21/6	17/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend forecast.

instrumentation where Elliott Brothers have a leading position.

G.E.C. New Shares

To-day (Friday) is the last day for holders of G.E.C. ordinary stock to notify their acceptance of the new £1 shares allotted to them by way of rights. They are called on to subscribe half the issue price of 40s upon acceptance, the other 20s not being due until the first week of January. In the ordinary way the selling of rights to this type of issue is at its heaviest, naturally enough, in the period before the first cash payment falls due. More often than not, that stage is followed by a recovery in the price of the shares concerned. In this case, it is recalled that earlier in the present year G.E.C. shares were quoted at more than £1 above their recent level of 42s 6d (ex rights). General market conditions have assisted largely in the decline, but an issue of over 4¼ million new shares takes a good deal of digesting in unsettled market conditions, and has doubtless made a large contribution towards it.

Electrical Investments

Company or Board	Nom. Value	Middle price 15th Oct.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Equipment and Manufacturing—continued						£ s d		
Hoover	5/-	23/-		70	50	10 17 6	39/3	23/-
I.C.I.	£1	40/3	−6d	10	10	4 19 6	49/9	39/9
Intl. Combustion	5/-	19/6		25	20*	5 2 6	25/-	15/3
Johnson & Phillips	£1	38/3	−6d	15	15	7 16 9	46/6	37/6
Lancashire Dynamo	£1	41/9		15	11*	5 5 6	49/9	40/9
Laurence, Scott	5/-	15/3		12½	15	4 18 3	16/9	13/3
Lister, R. A.	£1	29/6	−6d	9·3	10	6 15 6	35/3	27/6
London Elec. Wire	£1	45/9	−3d	12½	12½	5 9 3	52/9	46/5
Lucas, J.	£1	30/6	−9d	7½	7½	4 18 3	40/3	29/6
Marryat & Scott	2/-	9/6		30	30	6 6 3	11/3	9/6
Mather & Platt	£1	55/-		15	15	5 9 0	65/3	51/6
Metal Industries	£1	22/-	+1/-	9	9	—	27/-	16/3
Midland Elec. Mfg.	£1	45/-		10	12½	5 11 0	48/6	43/6
Morphy-Richards	4/-	26/3	+1/3	50	50	7 12 6	27/3	20/-
Murex	£1	72/6	−9d	20	20	5 10 3	74/6	60/-
Newman Ind.	2/-	2/3		10	10	8 17 9	2/9	2/1
Oldham & Son	1/-	2/6		20	17½*	7 0 0	3/-	2/3
Parnall (Yate)	5/-	5/6		14	12	10 18 3	9/6	5/6
Parsons, C. A.	£1	86/3		10	10	2 6 3	96/-	61/6
Plessey	10/-	66/6	−1/6	27½	30‡	4 10 3	87/6	56/-
Pye "A" Deferred	5/-	15/-	−9d	12½	12½	4 3 3	21/3	14/-
Reyrolle	£1	97/6	−7/6	15	16½	3 6 9	117/6	81/-
Rheostatic	4/-	9/9		18½	12‡	4 19 0	—	8/3
Richardsons Westgarth	5/-	16/-		16½	16½	5 4 3	17/-	13/9
Scottish Cables	4/-	15/9		27½	27½	6 19 3	17/9	15/9
Smith (England), S.	4/-	10/6	−3d	17½	17½	6 13 3	14/3	10/6
Southern Areas	£1	15/-	−1/3	10	7½	10 0 0	28/9	15/-
Strand Elec.	5/-	7/9		15	15	9 13 6	8/6	6/9
Sturtevant	5/-	23/6	−6d	14·4†	15†	3 3 9†	31/3	22/6
Sun Elec.	£1	33/9	−5/-	15	20	11 17 0	37/6	33/9
Switchgear & Cowans	5/-	13/6	−6d	20	25	9 5 3	17/-	13/6
Taylor Tunnicliff	5/-	11/3	−6d	15	15	6 13 3	14/-	11/3
T.C.C.	10/-	36/3		25	25	6 18 6	45/-	36/3
T.C. & M.	£1	26/-	−1/-	8½	8½	6 10 9	34/-	26/-
Telephone Mfg.	5/-	7/-		10	10*	7 2 9	8/6	6/3
Thorn Elec.	5/-	18/-	+1/3	15	15	4 3 3	22/6	16/-
Thornycroft	£1	45/-	−6d	15	15*	6 13 3	49/9	41/3
Tube Investments	£1	55/-	−9d	22½	14*‡	5 1 9	70/6	54/9
Vactric	5/-	13/6	−6d	15	17½*	6 9 9	15/-	11/6
Veritys	5/-	9/-		12½	12½	6 19 0	10/-	6/9
Walsall Conduits	4/-	12/9	−3d	70	20*	6 5 6	13/6	10/9
Ward & Goldstone	5/-	38/-	−1/6	30	35	4 12 0	39/6	29/-
Watford	2/-	6/9	−3d	25	25	7 8 3	7/6	6/-
Westinghouse	£1	72/6		18	18	4 19 3	100/-	71/6
West, Allen	5/-	12/-	−9d	15	15	6 5 0	14/6	11/6
Wolf Electric	5/-	17/6		20	20	5 14 3	26/3	17/6
Trusts, Transport and Communications								
Anglo-Portuguese	£1	21/9		8	8	7 7 0	23/6	20/3
British Elec. Traction: Def. Ord. "A"	5/-	18/6		22½	22½	6 1 6	20/-	15/6
Cable & Wireless: Ord.	5/-	10/6		10	10	4 15 3	11/3	9/6
4% Loan	100	90½		4	4	4 8 6	92½	88
Calcutta Trams	£1	26/9	+6d	6†	7½†	5 12 3†	27/6	23/-
Cape Elec. Trams	£1	16/3		8	8	9 17 0	20/3	18/-
Marconi Marine	£1	31/-		10	10	6 9 0	34/-	31/-
Oriental Tel. Ord.	1/-	70/-	−2/6	16	—	—	90/-	67/6
Telephone Rentals	5/-	11/-		12½	12½	5 13 9	11/9	9/9

Loan Stock

Dealings began this week in the General Electric Company's 6 per cent unsecured loan stock, of which £6 million was offered to stockholders concurrently with the ordinary share issue, and was readily taken up by them at par. In early dealings the stock was dealt in at a premium of a point on the issue price, so that new buyers can see a return of practically 6 per cent on the investment. Redeemable between 1976 and 1981, the stock is at present £25 per cent paid, with two further instalments due in November and January, until when it will be transferable free of stamp duty.

Company News

Switchgear & Cowans were expected to post to-day (Friday) allotment letters in connection with the offer of 200,000 new 5s ordinary shares, at 10s 6d, to present shareholders. Holophane 5s ordinary shares remained with little change at 21s 3d, after the declaration of the final dividend. This makes a total of 30 per cent, as before, on account of the year ended last June. Net profits, after tax, are about 14 per cent lower at £57,000, but this still provides more than twofold cover for the amount of the dividend payment. The yield on the shares is a fraction over 7 per cent. Final dividend declarations are expected from Crompton Parkinson on the 25th, and from Contactor Switchgear on the 23rd, of this month.

Metal Industries

The £1 shares of Metal Industries recovered further to 22s 3d after the annual meeting, at which the Chairman thought it would be possible for the company to re-enter the dividend list, on a modest scale, in respect of the current year. Among the points he made was the reference to the sale of the group's Sentinel (Shrewsbury) subsidiary, the proceeds of which would make a substantial contribution towards capital expenditure on the re-equipment of other factories in the group. In the electrical divisions, unprofitable ventures had been closed and other measures were beginning to show results. He thought that long-term prospects were assured, and proposed to issue shortly an interim report covering the first part of the current year.

REPORTS and DIVIDENDS

Veritys, Ltd.—Mr. H. B. T. Wilde, chairman of Veritys, Ltd., has informed stockholders that the directors have considered the share exchange offer from the Limit Engineering Group and are unanimous that the products of the two companies are complementary and that substantial benefits should accrue from the merger. Furthermore, the majority of the directors consider the offer to be reasonable and are prepared to recommend acceptance, but Mr. P. E. C. Merryfield and Mr. J. A. Robertson are not satisfied that it is adequate. Cooper Brothers & Co., chartered accountants, have therefore been requested to examine the position and report, so that the board may have independent advice, and stockholders will be advised as soon as possible.

Keith Blackman, Ltd., has acquired the majority shareholding of the Blackman Export Co., Ltd., giving it control of the company. Upon the resignation of the existing board the following directors were appointed:—Mr. D. S. Woodley (chairman), Mr. A. L. Ayton (secretary) and Mr. A. H. Woodley. Under the new management the company will continue its normal activities from its present address at 23, Queen Square, Southampton Row, London, W.C.1.

Phœnix Telephone & Electric Holdings, Ltd.—The annual meeting was held on 12th October, Mr. G. F. Shipman (chairman) presiding. In his circulated statement the chairman said that during the year under review they had accepted an offer from the minority shareholder in Clarion Equipment, Ltd., for the Phœnix Telephone & Electric Works, Ltd.'s 75 per cent shareholding in that company. Output and sales for the current financial year showed encouraging increases as compared with the corresponding period of the preceding year, and the volume of orders in hand was sufficient to absorb output for many months ahead.

The General Electric Co., Ltd., announces that the issue of £6,000,000 6 per cent unsecured loan stock, 1976-81, at par, was oversubscribed and the basis of allotment is as follows:—Up to £6,000 stock, the allotment is in full; over £6,000, applicants receive 50 per cent with a minimum of £6,000. To-day is the last day for acceptance or application for the rights issue of ordinary shares.

Thos. W. Ward, Ltd., report a group profit of £2,729,180 for the year to 30th June last, as compared with £2,352,529 for the preceding year, and after providing £100,000, subvention payment by the parent company to a subsidiary not included in the consolidation, and £1,386,483 for taxation, there is a net balance of £1,242,697 (against £1,136,972). General reserve receives £500,000, and it is proposed to pay a final dividend of 10 per cent, maintaining the distribution for the year at 15 per cent. The balance carried forward is £601,982 (against £567,169 brought in).

Switchgear & Cowans, Ltd.—Details have now been announced of the rights offer of ordinary shares. The directors have decided to issue 200,000 5s shares at 10s 6d per share in the proportion of two for every seven held. The new shares will not rank for the interim dividend of 10 per cent on the existing shares paid on 10th October.

The Perak River Hydro-Electric Power Co., Ltd., reports a profit for the year to 31st July last, before providing £315,000 for taxation, of £602,910, as compared with £660,200 for the preceding year. General reserve receives £125,631 and it is proposed to pay a final dividend of 6 per cent on the £2,187,500 ordinary capital, making 10 per cent for the year. For the previous year there was a single payment of 10 per cent on £1,750,000 capital before a 25 per cent scrip issue.

Stothert & Pitt, Ltd.—The profit for the year ended 30th June last, after allocating £332,712 for taxation, is £413,324, as compared with £403,981 for 1954-55. It is proposed to pay a final dividend of 12½ per cent, making 17½ per cent on the present £1,000,000 ordinary capital. A similar distribution was made in the previous year before a 7-for-13 scrip issue. The balance carried forward is £82,323 (against £87,556 brought in).

Holophane, Ltd.—The profit for the year ended 30th June last is £123,717, and after providing £67,000 for taxation the net balance is £56,717 (against £65,793). It is proposed to pay a final dividend of 22½ per cent, making 30 per cent for the year (unchanged). The balance carried forward is £94,894 (against £64,053 brought in).

Solus Teoranta (the Irish lamp manufacturing concern) reports a profit for the year ended 30th June last of £61,308, as compared with £53,826 for the previous year, subject to depreciation of £23,712 and taxation of £24,000. The dividend for the year is 10 per cent on capital doubled by a scrip issue. The distribution for the previous year on the old capital was 12½ per cent.

Reliance-Clifton Cables & Industrial Products, Ltd., has announced an interim dividend of 5½ per cent (against 11 per cent) on doubled capital.

The Calcutta Electric Supply Corporation, Ltd., has announced an interim dividend of 3 per cent, tax free (unchanged).

The River Plate Electricity & Other Securities Corporation, Ltd., is paying an unchanged interim dividend of 6 per cent.

Babcock & Wilcox, Ltd., have declared an interim dividend of 7 per cent (unchanged).

The Engineering & Lighting Equipment Co., Ltd., is paying an unchanged interim dividend of 5 per cent.

New Companies

Westfield Electric Co., Ltd.—Registered 25th September. Capital £3,000. Electrical engineers, etc. Directors: F. Harrison and Mrs. Norah E. Harrison. Regd. office: 40, Duke Street, Sheffield.

Gatton Electrical, Ltd.—Registered 24th September. Capital £100. Electrical engineers and contractors, etc. Directors: J. W. Nottage and Constance I. Nottage. Regd. office: 12, Criterion Mews, Upper Holloway, N.19.

Aviation Electrical and Radio Co., Ltd.—Registered 28th September. Capital £100. Permanent directors: W. B. Laughton and R. H. Fittall. Sec.: W. B. Laughton. Regd. office: Moons Lane, Horsham, Sussex.

G. K. Rhodes & Co., Ltd.—Registered 2nd August. Capital £1,000. Electrical and mechanical engineers, electricians, etc. Directors: G. K. Rhodes and Gwendoline M. Rhodes. Regd. office: 130, Vaughan Road, Harrow, Mdx.

Farrell, Anderson & Co., Ltd.—Registered 1st October. Capital £1,000. Manufacturers of and dealers in electrical goods of all kinds, etc. Directors: E. Farrell and Dorothy Anderson. Sec.: E. Farrell. Regd. office: 226, Haworth Road, Bradford.

Keating & Rumens, Ltd.—Registered 1st October. Capital £3,000. Electrical engineers, etc. Directors: P. J. Rumens and K. Rumens. Regd. office: 334, Green Lanes, Palmers Green, N.13.

Edwards Radio (Clapham), Ltd.—Registered 26th September. Capital £2,500. Television, radio and electrical engineers, etc. Directors: A. Edwards and H. H. Smith. Regd. office: 12, Buckingham Street, Strand, W.C.2.

Increase of Capital

Asea Electric, Ltd.—Increased by £250,000 in 250,000 ordinary shares of £1 each, beyond the registered capital of £750,000.

Liquidations

The Lindley Thompson Transformer & Service Co., Ltd.—Winding up voluntarily. Liquidator, Mr. H. A. Merchant, 48-50, Uxbridge Road, London, W.5, appointed 1st October.

[This notice is a formal one and relates to a reconstruction for purely internal administrative purposes. From a trading standpoint the business is completely unaffected. The operating subsidiary is being wound up; the holding company is henceforth to operate the business under the name, Lindley Thompson Transformer & Service Co., Ltd.]

M.M.J. Radio & Television Co., Ltd.—Meeting of members and creditors on 8th November at 11-12, Finsbury Square, London, E.C.2, to receive an account of the winding-up by the liquidator, Mr. N. Osborne.

Electrical Accessories (Lancaster), Ltd.—Meetings on 13th November at the offices of Parkin S. Booth & Co., 5, Rumford Place, Chapel Street, Liverpool, to receive an account of the winding-up by the liquidator, Mr. R. P. Booth.

Streetly Sales (Staffs), Ltd., radio and television retailers.—Winding up voluntarily. Liquidator, Mr. R. F. Bendall, 126, Colmore Row, Birmingham, 3, appointed 27th September.

Bankruptcy

A. J. L. Fleming, 54, Fore Street, Buckfastleigh, Devon, electrical engineer.—Last day for receiving proofs for dividend 20th October. Trustee, Mr. F. B. Goodman, 24, Lockyer Street, Plymouth, Official Receiver.

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged.

Monday, 22nd October

CARDIFF.—At the South Wales Institute of Engineers, Park Place, 6 p.m. I.E.E. Western Utilisation Group. Visit of the chairman of the Utilisation Section, H. J. Gibson.

LEEDS.—24, Aire Street, 6.15 p.m. I.E.S. Leeds Centre. "Decorative Lighting and the Designer's Approach," by D. W. Durrant.

LEICESTER. — E.M.E.B., Charles Street, 6 p.m. I.E.S. Leicester Centre. "Aviation Lighting," by H. M. Ferguson.

LONDON.—Savoy Place, 5.30 p.m. I.E.E. Radio & Telecommunication Section. Informal evening on "The Use of Transistors in Radio and Television." Talks by Dr. A. J. Biggs and E. Wolfendale.

NEWCASTLE-UPON-TYNE. — Neville Hall, 6.15 p.m. I.E.E. North-Eastern Centre. Informal lecture on "The British Electricity Delegation's Recent Visit to Russia," by N. F. Marsh.

Tuesday, 23rd October

CAMBRIDGE.—Cavendish Laboratory, 8 p.m. I.E.E. East Anglian Sub-Centre. "The Generation and Synthesis of Music by Electrical Means," by A. Douglas.

COVENTRY.—Electricity Sports & Social Club, Merrick Lodge, St. Nicholas Street. Coventry Electric Club. "The Electron Microscope," by A. Hewett Emmett.

EDINBURGH. — The Little Theatre, 60, Pleasance, 7.30 p.m. Edinburgh Electrical Society. "Wind Tunnel Testing of High Speed Aircraft," by Dr. W. F. Hilton.

GLASGOW. — A.S.E.E. Glasgow Branch. Visit to Fire Headquarters, Ingram Street, at 7.30 p.m.

HUDDERSFIELD.—Y.E.B., Market Street, 7 p.m. I.E.E. North Midland Graduate & Student Section. "The Testing and Construction of Power Transformers," by R. J. Kennett.

LONDON.—Savoy Place, 5.30 p.m. I.E.E. Measurement & Control Section. Discussion on "The Use of Electronic Computers in Nuclear Reactor Design Studies," opened by R. W. Sutton.

At the Royal Society of Arts, John Adam Street, W.C.2, 7 p.m. Institution of Works Managers, London Branch. Annual general meeting, followed by "Work Study," by J. B. Kitchin.

MANCHESTER. — Engineers' Club, Albert Square, 6.15 p.m. I.E.E. North-Western Measurement and Control Group. "The Manchester University Mark II Digital-Computing Machine," by Dr. T. Kilburn, Dr. D. G. B. Edwards and Dr. G. E. Thomas.

Y.M.C.A., Peter Street, 7.15 p.m. Institute of Industrial Technicians. "The Manchester University Computers," by E. T. Warburton.

NOTTINGHAM.—College of Art and Crafts, Waverley Street, 6.30 p.m. I.E.E. East Midland Centre. "Atomic Energy Programme," by R. A. Peddie.

SOUTHAMPTON.—The University, 7 p.m. I.E.E. Southern Graduate & Student Section. Chairman's address, by J. Williamson.

Tuesday, 23rd October, to Friday, 26th October

LONDON.—Olympia. Annual Dairy Show.

Wednesday, 24th October

CHESTER.—5, Kings Buildings, King Street, 7 p.m. Society of Instrument Technology, Chester Section. "pH and its Measurement," by J. C. Farquhar.

LONDON.—Savoy Place, 5.30 p.m. I.E.E. Supply Section. Chairman's address, "Engineering Efficiency, Economics and Expediency," by P. J. Ryle.

Waterloo Bridge House, S.E.1, 5 p.m. Institution of Post Office Electrical Engineers, London Centre, informal meeting. Vice-chairman's address, "The Main Line Transmission Plan and Performance," by A. J. Jackman.

MANCHESTER. — Engineers' Club, Albert Square, 2.30 p.m. Institute of Fuel, North-Western Section. Paper on Nuclear Energy, by I. Hopkins.

RUGBY.—College of Technology & Arts, 6.30 p.m. I.E.E. Rugby Sub-Centre. "Mine Locomotives," by T. E. Green. (Joint meeting with the Rugby Engineering Society.)

Thursday, 25th October

CHELMSFORD. — Public Library, 7 p.m. I.E.E. London Graduate & Student Section, district meeting. Chairman's address, "The Story of the Submarine Cable," by K. W. E. Gravett.

GLASGOW.—39, Elmbank Crescent, 7 p.m. I.E.E. South-West Scotland Sub-Centre. "An Introduction to Computers," by P. A. V. Thomas.

LONDON.—Savoy Place, 5.30 p.m. Institution of Electrical Engineers, ordinary meeting. "Conduction and Induction Pumps for Liquid Metals," by Dr. L. R. Blake. (In conjunction with the British Nuclear Energy Conference.) (Utilisation Section paper.)

Royal Albert Hall, 3 p.m. Imperial College of Science & Technology. Celebration of Commemoration Day.

Grosvenor House, Park Lane, 7.15 for 8 p.m. Gauge & Tool Makers' Association. Annual dinner-dance.

MAIDSTONE.—Royal Star Hotel, 7.30 p.m. A.S.E.E. Kent Branch. Annual dinner.

MANCHESTER. — College of Technology, 7.30 p.m. Association of Supervising Electrical Engineers. Ramsey Regional Lecture, "Atomic Energy, its Uses and Hazards," by Dr. F. W. Spiers.

SHEFFIELD. — Grand Hotel, 7.30 p.m. Incorporated Plant Engineers, Sheffield & District Branch. "A Practical Approach to Industrial Electronics," by A. M. Lock.

Friday, 26th October

BATH.—S.W.E.B., 7 p.m. I.E.S. Bath & Bristol Centre. "Light and the Eye," by D. Curry.

BIRMINGHAM. — Exchange & Engineering Centre, 6.30 p.m. I.E.E. South Midland Education Discussion Circle. Discussion on "Transistors," opened by Dr. D. D. Jones.

Regent House, St. Philip's Place, Colmore Row, 6 p.m. I.E.S. Birmingham Centre. "Aerodrome Lighting," by J. W. Morse.

BRISTOL. — Grand Hotel. Incorporated Plant Engineers, Western Branch. Annual dinner.

COVENTRY.—Leofric Hotel. Incorporated Plant Engineers, Birmingham Branch. Dinner-dance.

EDINBURGH.— The University, 7 p.m. British Institution of Radio Engineers, Scottish Section. "Modern Microwave Developments," by E. Jamieson.

GLASGOW.—425, Sauchiehall Street, 7.15 p.m. Society of Instrument Technology, Scottish Section. "A Flexible Electronic Recorder Controller," by S. A. Bergen.

HANLEY.—Twyford Scout Hall, 7 p.m. I.E.E. North Staffordshire Sub-Centre. "The Potentialities of Railway Electrification at the Standard Frequency," by E. L. E. Wheatcroft and H. H. C. Barton.

KETTERING.—George Hotel. I.E.E. East Midland Centre. Kettering district annual ball.

MANCHESTER.—Café Royal, Peter Street. Institution of Heating & Ventilating Engineers, Manchester & District Branch. Ladies' evening.

SWANSEA.—Langland Bay Hotel, Mumbles, 7 for 7.30 p.m. I.E.E. West Wales (Swansea) Sub-Centre. Annual dinner and dance.

WEYMOUTH.—South Dorset Technical College, 6.30 p.m. I.E.E. Southern Centre, district meeting. "The Breakdown of Electrical Insulation," by J. H. Mason.

TRADE MARK APPLICATIONS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 26th October:—

MULTICON. No. 746,285. Class 9. Television cameras; and television camera pick-up tubes.—Pye, Ltd., Radio Works, St. Andrews Road, Cambridge.

SUPERMATIC. No. 749,277. Class 9. Electrically actuated hydraulic door openers.—National Pneumatic Co., Inc., Boston, Mass., U.S.A. Address for service, c/o Haseltine, Lake & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2.

BULOVA. No. 753,349. Class 9. Measuring apparatus and instruments, radar apparatus, loudspeakers, phonographs, electronic time registering apparatus and photographic copying apparatus and parts and fittings for these goods; electric relays, batteries; and television and photographic apparatus and instruments.—Bulova Watch Co., Ltd., Toronto, Canada. Address for service, c/o Haseltine, Lake & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2.

No. B753,751 (design). Class 9. Radio apparatus; and sound reproducing and recording apparatus and instruments.—W. W. McCorkell, trading as Transitor Sound Products (Belfast), 76, King Street, Belfast.

REGENT. No. 754,210. Class 9. Electric vacuum cleaning apparatus and parts and fittings.—Bylock Electric, Ltd., 109, South Street, Enfield, Middx.

ARISTOCRAT. No. 755,165. Class 9. Electric vacuum cleaners and electric polishing machines for domestic purposes.—North-Western Electrics (London), Ltd. 47, Dunston Road, London, N.W.11.

TYRAD. No. 748,931. TYRAD (design). No. 748,932. Class 11. Electrical installations and apparatus for space heating.—Tyrad Electric, Ltd., Imperial Court, Basil Street, Knightsbridge, London, S.W.3.

DOMINO. No. 751,202. Class 11. Electric lamps and lighting fittings.—Thorn Electrical Industries, Ltd., 105 to 109, Judd Street, London, W.C.1.

New E.A.W. Branch

The Canterbury Branch of the E.A.W. was formed at a meeting on 24th September, when the chair was taken by the chairman-elect of the new Branch, Mrs. D. S. Thompson. The chief speakers were Miss Norah Balls, J.P., chairman of the National Executive Committee, and Ald. Commander D. S. E. Thompson, R.N. (ret.), chairman of the South Eastern Electricity Consultative Council. Representatives of the South Eastern Electricity Board were present. Mrs. Lock was appointed hon. secretary of the Branch and Mrs. Clarke was elected hon. treasurer.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 24th October from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1950

23341. General Electric Co., Ltd.—Telecommunication systems embodying automatic exchanges. 31st August, 1951. (759682.) 23342. Multi-channel communication systems. 22nd September, 1950. (Divided out of 759681.) (759683.) 23343. Switching devices. 31st August, 1951. (759684.) 23344. Coding devices for use in automatic telephone exchanges. 31st August, 1951. (759685). 23345. Calling line identification systems for automatic telephone exchanges. 20th September, 1951. (759686.) 28703. Automatic exchanges. 23rd November, 1951. (759687.) 28704. Telecommunication systems embodying automatic exchanges. 23rd November, 1951. (759688.) 28705. Automatic exchanges. 23rd November, 1951. (759689.)

29178. General Electric Co., Ltd., and Chubb, A. A.—Automatic telephone systems. 27th September, 1951. (759690.)

1951

2594 and 3859. General Electric Co., Ltd.—Automatic telephone systems. 31st January and 11th February, 1952. (759692/3.)

18232. Berghaus, B. (trading as Elektro-Physikalische Anstalt B. Berghaus).—Methods and apparatus for carrying out processes for the treatment of objects and materials employing electric glow discharge. 1st August, 1951. (759694.)

1952

7418. Soc. de la Pile Leclanche.—Electric batteries of inert or dry cells. 21st March, 1952. (759584.)

7519. British Thomson-Houston Co., Ltd.—Accelerometers. 24th March, 1953. (759585.)

13628. Fisher & Ludlow, Ltd.—Washing machine. 23rd February, 1954. (759836.)

18627. Licentia Patent-Verwaltungs Ges.—Telephone system comprising a satellite exchange and a main exchange. 23rd July, 1952. (759589.)

22781. Simplex Electric Co., Ltd.—Method of and apparatus for supplying heat. 11th September, 1953. (759591.)

23124/5. Soc. Automata.—Electric feeler control systems for machine tools. 15th September, 1952. (759700/1.)

26128. Staatsbedrijf der Posterijen, Telegrafie en Telefonie.—Interconnecting of subscribers' lines in final selectors. 17th October, 1952. (759756.)

32325. Holophane, Ltd., and Holmes, J. G.—Lighting fittings. 16th March, 1954. (Cognate application 647, 8th January, 1953.) (759847.) 32326. Lighting fittings for road, runway and like surfaces. 17th March, 1954. (759848.)

1953

2403. Fisher & Ludlow, Ltd.—Domestic washing machines. 24th March, 1954. (759849.)

3848. Licentia Patent-Verwaltungs-Ges.—Telephone system with a main exchange and a satellite exchange. 11th February, 1953. (Addition to 759656.) (759758.) 4529. Telecommunication system with relay selectors. 18th February, 1953. (759597.)

4250/1. Adamson, R. A.—Electrically heated soldering irons. 16th February, 1954. (759850/1.)

7108. Wood & Co., Ltd., H.—Electrically operated signalling systems. 12th March, 1954. (Cognate application 30559, 5th November, 1953.) (759852.)

11560. British Thomson-Houston Co., Ltd.—Current control circuits. 27th April, 1954. (759706.)

12889. Siemens Bros. & Co., Ltd.—Automatic exchange systems. 7th May, 1954. (759599.)

13414. Williamson Manufacturing Co., Ltd.—Devices for giving electrical impulses at predetermined intervals. 11th May, 1954. (759904.)

15598. Rheostatic Co., Ltd.—Electric immersion heaters. 25th May, 1954. (759906.)

16112. British Thomson-Houston Co., Ltd.—Electric discharge lamps having double walled envelopes. 11th June, 1953. (759907.)

19650. British Thomson-Houston Co., Ltd.—Equalisation of load between mechanically coupled electric motors. 15th July, 1954. (759707.)

19947. Antiference, Ltd., and Best, N. M.—Aerials. 1st October, 1954. (759605.)

20993. General Electric Co., Ltd.—Party line telephone systems. 4th October, 1954. (759607.)

21327. Hunt (Capacitors), Ltd., A. H.—Manufacture of electrical capacitors. 30th July, 1954. (Addition to 647573.) (759911.)

22392. Reyrolle & Co., Ltd., A.—High voltage switchgear. 12th November, 1954. (Cognate application 25655, 16th September, 1953.) (759708.)

23327/8. British Dielectric Research, Ltd.—Manufacture of electric capacitors. 24th August, 1954. (759613/4.)

23428. British Insulated Callender's Cables, Ltd.—Electric capacitors. 19th November, 1954. (759914.)

26284. United Kingdom Atomic Energy Authority.—Electrically conducting cements. 24th September, 1954. (759916.)

26868. Metropolitan-Vickers Electrical Co., Ltd.—Mass spectrometers. 19th October, 1954. (759917.)

29557. General Electric Co.—Insulation. 26th October, 1953. (759921.)

29683. Metropolitan-Vickers Electrical Co., Ltd.—Polyphase electrical meters. 27th October, 1954. (759922.)

31692. Fitzgibbon & Murray, Ltd.—Electric switch lampholders. 16th November, 1954. (759927.)

32289. Siemens Bros. & Co., Ltd.—Automatic exchange systems. 12th November, 1954. (759631.)

32899. Murex, Ltd.—Moving coil electrical instrument. 19th November, 1954. (759928.)

33364. General Electric Co., Ltd., and Neill, T. R.—Cold cathode electric glow discharge devices. 1st December, 1954. (759929.)

33520/1. General Electric Co., Ltd., and Ketteringham, T. A.—Electric furnaces. 2nd December, 1954. (759777/8.)

34668. Electric & Musical Industries, Ltd.—Circuit arrangements including potentiometers. 25th November, 1954. (759934.)

36054. Western Electric Co., Inc.—Travelling wave tubes. 29th December, 1953. (759937.)

36305. British Petroleum Co., Ltd., formerly Anglo-Iranian Oil Co., Ltd., and Threadgold, P.—Measurement of electrical signals in boreholes. 14th January, 1955. (759861.)

1954

3526. Maul, M.—Record card controlled cross computing machines. 5th February, 1954. (759639.)

6093. General Electric Co., Ltd.—Electric circuit arrangements incorporating cathode-ray tubes. 2nd March, 1955. (759944.)

6758. Electric & Musical Industries, Ltd.—Electric resistance heating elements. 4th March, 1955. (759946.)

7593. Soc. des Accumulateurs Fixes et de Traction.—Process of manufacture of sintered plates for galvanic cells. 16th March, 1954. (759788.) 7594. Process of manufacture of electrodes for galvanic cells. 16th March, 1954. (759789.) 7595. Method of and apparatus for the manufacture of electrodes for galvanic cells. 16th March, 1954. (759790.)

10555. Allis-Chalmers Manufacturing Co.—Electric liquid-blast circuit interrupter employing axially arranged barrier plates for interrupting series arcs. 9th April, 1954. (759794.) 10556. Electric liquid-blast circuit-breaker contact actuating mechanism with separable connection to oil pump. 9th April, 1954. (759795.) 11560. Liquid-blast electric circuit interrupter with barrier plates forming a U-shaped passage. 21st April, 1954. (759796.) 11561. Electric liquid-blast circuit-breaker with electrode disposed between an interrupting device and a contact opening. 21st April, 1954. (759797.) 11562. Electric liquid-blast circuit-breaker with arc restraining members in liquid supply passageways. 21st April, 1954. (759798.)

12120. Licentia Patent-Verwaltungs Ges.—Telephone system with line finders. 27th April, 1954. (759645.)

12348. Wood & Co., Ltd., H.—Switching means in or for remote controlled electrical signalling or other systems. 28th April, 1955. (759873.)

12617. Burndept, Ltd.—Electric dry batteries. 22nd April, 1955. (759874.)

13487. Redmond Co., Inc.—Electric motor stator with moulded insulation. 7th May, 1954. (759960.)

15837. Standard Telephones & Cables, Ltd.—Supervisory equipment for television signals. 28th May, 1954. (759803.)

19191. British Insulated Callender's Cables, Ltd.—Apparatus for the manufacture of helically striped extruded coverings on cores. 29th June, 1955. (759882.)

19765. Akt.-Ges. Brown, Boveri & Cie.—Moving contact convertor. 6th July, 1954. (759970.)

21563. Western Electric Co., Inc.—Wiring tool for interconnecting electrical terminals. 23rd July, 1954. (759650.) 21564/5. Apparatus for interconnecting electrical terminals. 23rd July, 1954. (759651/2.)

22882. Allmanna Svenska Elektriska Aktiebolaget.—Cooling and protection means for electrical stirring windings. 6th August, 1954. (759806.) 22884. Supporting means for the laminated yokes of electrical stirring windings. 6th August, 1954. (759807.)

23903. Licentia Patent-Verwaltungs-Ges.—Telephone system comprising a main exchange and a satellite exchange. 23rd July, 1952. (Divided out of 759589.) (759656.)

24568. Lucas (Industries), Ltd., J.—A.c. generator and storage battery systems for use on motorcycles or other road vehicles. 22nd August, 1955. (759885.)

24905. Avery, Ltd., W. & T. (Schenck Maschinenfabrik Ges., C.).—Device on instruments for the electrical indication of unbalance of revolving articles. 27th August, 1954. (Addition to 756168.) (759809.)

27678. General Electric Co.—Automatic temperature control systems. 24th September, 1954. (759661.)

28839. Trub, Tauber & Cie. Soc. Anon.—Arrangements for the kinematic investigation of structure by means of an electron or other corpuscular beam. 6th October, 1954. (759985.)

28896. Yale & Towne Manufacturing Co.—Electromagnetic contactor. 7th October, 1954. (759986.)

29526. General Electric Co.—Aluminium to copper connectors *inter alia* for electrical conductors. 13th October, 1954. (759722.)

29539. Sigma Instruments, Inc.—Electromagnetic relay devices. 13th October, 1954. (759723.)

29774. British Thomson-Houston Co., Ltd.—Mounting of inductive devices. 15th October, 1954. (759987.)

(*Continued at foot of page 741*)

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia.—29th November. Electricity Trust of South Australia. Shunt reactors. (E.S.B. 24562/56. Ten/21875.)*

12th November. Electricity Commission of New South Wales. Four 11 kV, 1,000 MVA circuit-breakers for reactor switching. (See this issue.) 3rd December. 330 kV steel tower transmission line. (See this issue.)

20th December. Sydney C.C. Nine 13·5 MVA and one 12 MVA power transformers. (E.S.B. 25341/56. Ten/21877.)*

Axminster.—24th November. R.D.C. Two electrically-driven sewage pumps. Silcock and Simpson, consulting engineers, 10, Park Row, Leeds, 1.

Belgian Congo.—6th November. Ministry of Colonies, Brussels. Telephone cables and accessories. (E.S.B. 25713/56. Ten/21969.)*

Brazil.—6th November. Estrada de Ferro Central do Brasil. 10 MVA substation. (E.S.B. 25047/56. Ten/21892.)*

Burma.—29th October. Union Purchase Board. Copper jointing sleeving and cable sweating sockets. (E.S.B. 26199 and 26202/56. Ten/22051-2.)* 30th October. Steel conduit and fittings. (E.S.B. 25449/56. Ten/21988.)* Electric lamps. (E.S.B. 25501/56. Ten/21910.)* 1st November. Batteries. (E.S.B. 25508/56. Ten/21945 and E.S.B. 25504/56. Ten/21959.)* Insulators. (E.S.B. 25507/56. Ten/21935.)* Valves and condensers. (E.S.B. 25513/56. Ten/21943.)* 6th November. Pin plugs and sockets. (E.S.B. 25532/56. Ten/21907.)* 7th November. Electric lamps. (E.S.B. 25524/56. Ten/21917.)* Fluorescent lighting fittings. (E.S.B. 25537/56. Ten/21958.)*

Burton Latimer.—10th November. U.D.C. Street lighting equipment. (See this issue.)

India.—31st October. Government of Mysore. L.v. underground cables and accessories. (E.S.B. 25235/56. Ten/21872.)* Underground cables and potheads. (E.S.B. 25231/56. Ten/21876.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

NEW PATENTS *(continued from page 740)*

31365. Radio Corporation of America.—Automatic gain control system for semiconductor devices. 29th October, 1954. (759665.)

32339. Cary, Ltd., W. E.—Cable trunking. 3rd October, 1955. (759894.)

32484. English Steel Corporation, Ltd.—Electrode holders for hand welding. 10th November, 1954. (759991.)

32840. Reyrolle & Co., Ltd., A.—High voltage electric switchgear. 12th November, 1954. (Divided out of 759708.) (759729.)

33545. International Business Machines Corporation.—Electronic commutator. 19th November, 1954. (759732.)

36105. Standard Telephones & Cables, Ltd.—Magnetic recording and reproducing equipment. 14th December, 1954. (759738.)

36388. Reyrolle & Co., Ltd., A.—High voltage switchgear. 15th December, 1954. (Divided out of 759708.) (759739.)

37175. Schlatter Akt.-Ges., H. A.—Electrical flash welding machines for welding rails. 23rd December, 1954. (760000.)

6th November. Director General of Supplies and Disposals. Electrically-driven borehole pump. (E.S.B. 25702/56. Ten/21951.)*

Ipswich.—19th November. Borough Council. Electrical installation in Thurleston Secondary School. (See this issue.)

Irish Republic.—19th November. Kerry C.C. Two electrically-driven pumping sets for Milltown water supply scheme. (E.S.B. 25561/56. Ten/21930.)*

Kintore.—3rd November. Burgh Council. Street lighting equipment. (See this issue.)

London.—5th November. Lewisham B.C. Street lighting installation. (See this issue.)

6th December. India Stores Department. Paper-cutting machine for use in the manufacture of coaxial cables. (See this issue.)

Northern Ireland.—26th October. Management Committee. Electrical installation in additions to Forster Green Hospital. G. E. Taylor, secretary, Forster Green Hospital, Fortbreda, Belfast.

29th October. Northern Ireland Housing Trust. Electrical installations in 315 dwellings at Larne. Offices of the Trust, 12, Hope Street, Belfast.

29th October. Electrical installation in the new primary school, Mount Merrion, Belfast. Colum P. McNally, consulting engineer, 143, Royal Avenue, Belfast.

2nd November. Larne B.C. Electrical installation in 44 houses at Antiville, Larne. T. J. M. Davison, 46, Main Street, Larne, Co. Antrim.

Orpington.—12th November. U.D.C. Street lighting equipment. Surveyor, Civic Offices, The Walnuts, High Street.

Philippines.—2nd November. National Power Corporation, Manila. Two 1,000 kVA substations. (E.S.B. 25677/56. Ten/21953.)*

South Africa.—9th November. Stores Department, South African Railways. Six 1,250 kVA transformers. (E.S.B. 25596/56. Ten/21955.)* Steel and copper wire. (E.S.B. 25595/56. Ten/21971.)* Copper wire and steel cored aluminium conductor. (E.S.B. 25593/56. Ten/21937.)* 11th November. 12·8 kW generating set and switchboard. (E.S.B. 25641/56. Ten/21936.)*

Thailand.—9th November. Telephone Organisation of Thailand. Underground cable. (E.S.B. 25085/56. Ten/21865.)*

Uruguay.—27th November. Administración General de las Usinas Electricas y los Telefonos del Estado. Plugs, cords, crossover wire and dust aspirators. (E.S.B. 25644/56. Ten/21964.)*

ORDERS PLACED

Barrow-in-Furness.—Corporation. Electrical work at the County Grammar School for Girls (£6,021).—North Western Electricity Board.

Carlisle.—City Council. Electrical installations in 42 houses on the Morton estate.—Hartley Electromotives, Ltd. Supply and erection of 32 class "A" lighting columns and the erection only of 55 class "B" columns (£1,681).—B. L. Oliver.

London. — Lambeth Borough Council. Recommended. Conversion of gas lamps and bolards to electric lighting (£8,160).—London Electricity Board.

Shoreditch Borough Council. Electrical work at Block 15 on the St. Mary's estate (£1,846).—Alexander & Maiden (Electrical Contractors).

Poplar Borough Council Contracts and Purchasing Committee. Recommended. Electrical installations in 10 maisonnettes and 4 flats at Hesperus Crescent (£1,027).—Iverson Electrical Co.

Plymouth.—City Council. Recommended. Installation of socket outlets and spur units in 806 properties in the city (£7,200).—Scientific Electric Services.

Seaham (Durham).—U.D.C. Electrical work in connection with the erection of 98 houses on the Parkside estate.—J. Calvert (Electrical).

Stoke-on-Trent.—City Council. Recommended. Improved street lighting at the Boulevard and Victoria Park road, Tunstall; at Cobridge Road, Leek New Road, Etruria Road, Trinity Street, Old Hall Street and Bucknall New Road, Hanley (£11,791).—A.E.I. Lamp & Lighting Co.

Wolverhampton. — Corporation. Recommended. Electrical installations in dwellings in the first stage of the Dale Street redevelopment scheme (£36,709).—Williams Bros. (Electrical).

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Amble.—Houses (42); W. Charity, U.D.C. surveyor.

Ashington.—School, Green Lane; county architect, County Hall, Newcastle-on-Tyne.

Aylesbury.—Houses (161), Weedon Road extension; borough surveyor, Friarscroft, 3, Oxford Road.

Banbury.—Houses (82), in six parishes; A. Hunt, R.D.C. surveyor, Castle Wharf.

Barrow-on-Soar.—Houses (62), Thurmaston; A. Ward, architect, 31, Fowke Street, Rothley, near Leicester.

Birmingham.—Theatre on site at junction of Smallbrook Street and Hill Street, with shops and offices; Moss Empires, Ltd., Cranbourn Mansions, London, W.C.2.

Blaydon.—Factory for Val De Travers Asphalte Paving Co., Ltd., Westmorland Road, Newcastle-on-Tyne.

Bolton.—Six-storey block of flats, Crook Street; borough housing director.

Factory and offices, off Manchester Road; W. J. Kenyon & Co., Ltd., Burndean Bleach Works.

Border.—Houses (100) at Brampton; William Skerry, R.D.C. surveyor, Victoria Place, Carlisle.

Bridgwater.—Houses (98) on eastern extension of Sydenham estate; borough surveyor, Town Hall, Bridgwater, Somerset.

Cardiff.—Ten-storey block of flats at Corytown, Whitchurch (£200,000); S. P. Youldon, R.D.C. surveyor, 20, Park Place.

Colwyn Bay.—Houses and flats (62), Elwy Road estate, Rhos-on-Sea; N. S. Jeffrey, borough surveyor, Town Hall.

Consett.—Factory additions at Moorside, for R. B. Bolton and Co., Ltd.; Eltringham & Lowes, architects, Derwent Street, Blackhill.

Cranham.—Church and hall, Front Lane; Thompson & Whitehead, architects, 5, High Street, Romford.

Crosby.—Houses (90), Brownmoor Lane; T. W. Crooksdake, borough surveyor, Town Hall, Waterloo, Liverpool, 22.

Croydon.—Rebuilding bedding factory, Dingwall Road; Grant Bros., Ltd., departmental stores, 14, High Street.

Cupar.—Houses (64), Kirkgate/Bonnygate site; borough surveyor, Cupar, Fife.

Dagenham.—Shops with maisonnettes (16), Marks Gate estate; Keith Lauder, town clerk, Civic Centre.

Dronfield.—Houses and flats (76) and shops (4); U.D.C. surveyor, Council Offices, Manor House, High Street, Dronfield, Yorks.

Dumbarton. — Two-storey business premises in High Street, for the Equitable Co-operative Society, Ltd.; Scottish Co-operative Wholesale Society, Ltd., 74, Morrison Street, Glasgow.

Durham.—Fire station at Fence Houses; county architect, South Street.

Edinburgh.—Two ten-storey blocks of flats in vicinity of Holyrood Park; city engineer, 329, High Street.

Gateshead.—Fourteen-storey blocks of flats and secondary modern school at Hill Head; G. F. Winters, borough engineer.

Halesowen.—Factory, Lodgefield Road; Shotton Bros., Ltd., Manchester Road.

Hawick.—Houses (36) at Burnfoot and Burnhead, with electrical work, for T.C.; J. A. W. Grant, architects to Council, Melville Street, Edinburgh.

Hebburn.—Office block and factory additions for George Angus and Co., Ltd.; S. W. Milburn & Partners, architects, Esplanade, Sunderland.

Three nursery schools and a primary school; county architect, Durham.

Huddersfield.—Grammar-technical school, Salendine Nook; James Miller & Partners, Ltd., builders, Four Mile Works, Wakefield.

Lanchester.—Houses (36) at Langley Park; R.D.C. surveyor, Lanchester, Durham.

Leamington Spa.—Flats (39), Crown Way; borough surveyor.

Leicester.—Workshops and offices, Barkby Road; C. W. & A. L. Hughes, Ltd., 102, Baggrave Street.

Lexdean and Winstree.—Houses (74), on sites at Boxted, Eight Ash Green, Stanway and Tiptree; clerk, Rebow Chambers, Sir Isaacs Walk, Colchester.

London.—Offices, Cardington Street, St. Pancras; Kind & Co., Ltd., 564, High Road, E.11.

Houses and flats (46), Sunbury Road, Woolwich, with maisonnettes (50) on adjoining site; W. Ginson, borough engineer, Town Hall, S.E.18.

Maidenhead.—First phase of East Berks College of Further Education, Boyne Hill; county architect, Wilton House, Parkside Road, Reading.

Middlesbrough.—County secondary school, Pressick Farm (£153,000); A. V. Clerey & Sons, 14, Frederick Street, Sunderland.

Morecambe and Heysham.—Shopping arcade, vicinity of Winter Gardens; R. Rose, town clerk, Town Hall, Morecambe.

North Riding.—Proposed Marton and Nunthorpe County Schools for the C.C.; Morrison and Partners, architects, Belper Road, Derby.

Schools at Wilton, Malton and Scarborough; county architect, Northallerton.

Oldham.—Houses (87), Alt estate; James Hobson & Son, Ltd., builders, Drake Street, Rochdale.

Peterlee.—Methodist church, hall and minister's house (£50,000); R. Hudson and Sons, builders, St. Mark's Crescent, Sunderland.

Pinner.—R.C. church, Love Lane; Wm. Lacey, Ltd., builders, Hospital Road, Hounslow.

Rotherham. — Extensions to technical college; J. Roger Preston & Partners, mechanical consultants, 15, North Audley Street, London, W.1.

Rothwell.—Flats (88), Wood Lane site; Easdale & Son, architects to U.D.C., Bradley Street, Castleford.

Seaton Valley.—Houses (66) at Murton Grange; T. W. Burgess, U.D.C. surveyor.

Settle.—Houses (44), Mill Close site; J. N. Spencer, architect to R.D.C., Piccadilly, Bradford.

Sittingbourne and Milton.—Six blocks of flats on Staplehurst housing estate; U.D.C. surveyor, Central Avenue, Sittingbourne, Kent.

Slough.—Hospital, Wexham Park; Powell & Moya, architects, 36, Great Smith Street, London, S.W.1.

Solihull.—Houses (220), Lode Lane; borough surveyor, 90, Station Road.

Stanley (Co. Durham).—Houses (94) at Hill Top; U.D.C. surveyor, Council Offices.

Sunderland.—Houses (30) on the Pennywell estate for the T.C.; T. Stewart, builder, Peacock Street West.

Sutton and Cheam.—Houses (27), corner of Benhill Wood Road and Oakhill Road, Sutton; N. H. Mitchell, borough surveyor, Municipal Offices, High Street, Sutton, Surrey.

Sutton Coldfield.—Houses (124), Coppice Farm estate; Cooper Estates, Ltd., Wilmington House, Dartford, Kent.

Teddington.—Workshop and offices at National Physical Laboratory; W. E. Chivers & Sons, Ltd., builders, 34, Broadway, London, S.W.1.

Tipton.—Eight-storey block of flats on site in High Street, with further block of shops and flats; H. H. Woodward, borough surveyor, Sedgley Road West.

Tynemouth.—Secondary technical school (£228,326); G. H. Gray & Partners, Camden Street, North Shields.

Wallsend.—Stores at the junction of High Street and Station Road for F. W. Woolworth and Co., Ltd., 1, New Bond Street, London, W.1; own architects.

Block of offices (£30,000); Victor Products (Wallsend), Ltd., Church Bank.

Watford.—Offices, Clarendon Road; Sun Insurance Office, Ltd., 63, Threadneedle Street, London, E.C.2.

Factory extension, Colonial Way; H. & B. Precision Engineering & Tools Co., Ltd., 233, High Street.

Development of site in Ascot Road; Sun Printers, Ltd., gravure and letterpress printers, Head Office, 52, Long Acre, London, W.C.2.

Factory, Holywell estate; Gade Engraving Co., Ltd., Bridle Path.

Welwyn Garden City.—Factory; Burtonwood Motor & Aircraft Engineering Co., Ltd., Edgware Road, London, N.W.9.

Wembley.—Flats (48), North End Road; Raglan Property Trust, Ltd., King's Court, Forty Lane, Wembley.

Widnes.—Chemical works, Halton View; A. Boake Roberts & Co., Ltd., Carpenters Road, London, E.15.

Wigan.—Group pathological laboratory at Royal Albert Edward Infirmary (£57,174); secretary to Manchester Regional Hospital Board, Cheetwood Road, Manchester, 8.

Wisbech.—College of Further Education for Isle of Ely; Bettles Building Co., Ltd., Millfield, Peterborough.

Wolverhampton.—Works, Lower Horsley Fields; John Hickman & Sons (Sawmills), Ltd., Lower Walsall Street.

Worksop.—Flats (50), Kilton Hill; borough surveyor.

Worthing.—Dwellings (50), Salvington Road; C. T. Gardner, 2, Pool Valley, Brighton.

Transmission in N.S.W.

THE New South Wales Electricity Commission has decided to build steel tower transmission lines along more than 200 route miles between Sydney, Newcastle and Tamworth. These transmission lines—the first of their kind in the north and north-west area—will be largely for ultimate operation at 330 kV. They will transmit power from the major generating stations of the N.S.W. interconnected system, the growing N.S.W. share of power from the Snowy Mountains Scheme, and from new thermal stations to be built by the Commission in northern areas.

The route between Sydney and Lake Macquarie power station has already been surveyed and contracts for the construction work have been let. Survey of the section between Muswellbrook and Tamworth is now in progress, and survey of the intervening section between Lake Macquarie and Muswellbrook will begin shortly. At the present time the first power line for future operation at 330 kV is nearing completion over the 70 miles between Goulburn and Tallawarra power station (near Port Kembla). The new line will represent a major extension of this high voltage grid. The Muswellbrook-Tamworth line will consist of three twin conductors over a route of 80 miles for initial operation at 132 kV. The Lake Macquarie-Muswellbrook section (72 miles) will be a single circuit 132 kV line. Practically the whole route will be over open grazing country. The Sydney-Lake Macquarie line, starting from a new substation on the northern outskirts of the Sydney Metropolitan area, will be about 50 route miles (plus connections to the power sources at either end). It will be strung for initial operation as two 132 kV circuits, later combined to form one 330 kV circuit. This line will have a greater carrying capacity than any other in Australia. It will be built over some extremely difficult country and will cost about £1 million.

Plans are in hand for the installation by the Commission of large new generating units at existing power stations and at a new station under construction at Lake Macquarie, and sites for larger stations are being investigated in northern areas.

The Commission recently placed in operation two 132 kV underground cables directly linking Bunnerong power station with the main N.S.W. high voltage overhead network. The direct link is between an open switchyard at Bunnerong and a new substation at Canterbury, a distance of 8½ miles, and then by overhead lines to Homebush and the main power transmission lines to the north, south and west. The cable connection is only the second of its kind in Australia. There are two 3-cored impregnated pressure cables, manufactured in England and installed by British Insulated Callender's Cables (Australia) Pty., Ltd.

The new cable will enable some 33 kV cables to be released to the Sydney County Council and the Department of Railways for distribution purposes. Subsequently, Canterbury substation will be developed by the Commission as an important point of bulk supply for the southern metropolitan area. This new project is an important step forward in the work of integrating the resources of the Commission's existing stations with the major new stations being developed on the coalfields to meet the combined power demands of the States as a whole.